AN ENVIRONMENTAL PROFILE OF THE KALUTARA DISTRICT

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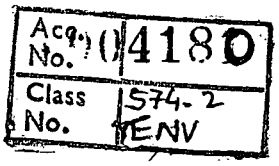
AN ENVIRONMENTAL PROFILE OF THE KALUTARA DISTRICT

A Report written by Dr. K. Abeynayake on work carried out with Dr. W. G. A. Nissanka, of a study sponsored by the Central Environmental Authority with NORAD collaboration.

Prepared in 1988



Printed at the State Printing Corporation, Sri Lanka.

FOREWORD

Sri Lanka's national energies and efforts during the last few decades have increasingly been towards the achievement of economic and social goals of development. However, unplanned development, without due regard to the protection and management of the environment, could lead to the reduction of the country's natural resources base and the degradation of the environment. The fruitful incorporation and integration of environmental considerations into the development strategies are fundamental to sustainable development. Unfortunately environmental concerns have not been incorporated into the planning process of some development projects and programmes. This has been mainly due to the lack of information on available human and natural resources, their utilization and development.

The Central Environmental Authority launched a programme to prepare District Environmental Profiles for each of the districts within the Island to identify and review the human and natural resources, their utilization, and significant environmental problems, associated with each district. I am grateful to the Norwegian Embassy for Development Co-operation (NORAD) for providing the necessary financial assistance to carry out this project.

The profiles have been prepared for the CEA by various competent and authoritative personnel and their ready cooperation in the successful completion of this exercise is duly acknowledged. The project has been managed by the Natural Resources Management Division of the CEA.

I trust that this Environmental Profile would serve as a tool in the future development planning process for effective protection and management of the environment.

G. K. Amaratunga
Chairman
Central Environmental Authority

December 1992.

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PREFACE

This project "An environmental profile of the Kalutara district" has been sponsored by the Central Environmental Authority in collaboration with NORAD. We are indeed very grateful to the CEA for selectig us to undertake this project. It must be admitted however that we undertook this project with a certain amount of hesitation but on really getting down to the work we enjoyed and gained a lot of experience and knowledge from it!

The work on this project would not have been possible without the able assistance of Miss. A. S. Beling who worked very hard at field work, laboratory experiments and the diagrams.

Carrying out the work on the project was made possible due to the co-operation and assistance we received from the Kalutara Kachcheri. Particular mention must be made of the ready assistance of Mr. K. V. S. Kumarasinghe — Divisional Development Officer who spared no pains to get our work going. He accompanied us on many of our preliminary field visits and even when he could not join us, made the necessary arrangements for site examination. Mr. L. K. D. L. Dhanapala, the Assistant Commissioner of Local Government too helped us whenever a problem arose.

Special mention also must be made of the ready assistance given to us by several people in establishments of the Kalutara district. The staff of the Wawulugala and Kalutara co-operative distilleries, and of the Chris Thombo Farm were especially helpful in our work supplying the necessary information and effluents without hesitation. All other institutions we visited in the Kalutara district, the Forest Department, Irrigation Department, IRDB Project Office, and Associated Motorways too were very helpful.

We also take this opportunity to thank the people from other institutions who helped us. Special mention must be made of members of the CEA especially Mrs. Nalini Amarasekera who helped us right through the project with the necessary literature and reports requested for. The ready assistance of Mrs. Dayanitha Sadacharan of the Coast Conservation Dept., Dr. P. A. J. Yapa of Rubber Research Institute, Dr. A. P. Mathes of the CISIR and the staff of NERD are gratefully acknowledged. The help of Mr. T. D. Ekman of the State Distilleries Corporation who provided us with literature and effluents is also acknowledged.

We are indeed thankful to the staff of the Botany Dept. who helped us in our work in various ways – especially to Professor B. A. Abeywickrama and Prof. R. N. de Fonseka and to the people in the Ecology and Taxonomy laboratory who bore the smells and mosquitoes our project generated without complaint.

Lastly we wish to thank Mrs. Malini Alwis and Mrs. Sandya Wanniarachchi of the Department of Botany for typing the first draft of the report and Miss. Nelun Fernando for typing the final report.

It is hoped that this report would generate the necessary interest, and stress the need for management of the environmental problems of the Kalutara district. In this report we have tried to point out where action plans are necessary and we have suggested initial steps/methods that could be adopted towards development of the action plans. We hope sincerely that action plans would be drawn up in the near future incorporating some of our recommendations, to preserve the tranquility, beauty and the environmental quality of the Kalutara district. we are ever willing to offer our services further to the CEA towards achieving this end.

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August 1988.

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CHAPTER 1

INTRODUCTION

The Central Environmental Authority in collaboration with NORAD has most appropriately made arrangements to make detailed studies to develop district environmental profiles in five selected districts of Sri Lanka with a view to develop action plans for the management of the environment. This report titled "an environmental profile for the Kalutara district" presents the investigations carried out for one such selected district — Kalutara.

Since the main aim of the CEA is to finally draw up action plans for the management of the environment of districts, it was felt that this report should stress the environmental problems of the district. The term environmental profile in this report has been therefore interpreted as a study of the environmental problems of the district. Thus too much emphasis will not be paid to the resource base, climatology etc., of the district. However depending on the particular environmental problem the necessary climatological and resource data would be discussed.

This type of detailed study is very important, essential and timely for Sri Lanka in its present context. Even though environmental problems have been known and were being discussed for over ten to fifteen years, environmental consideration had not been integrated into development plans of most projects. The harmful or deleterious effects of projects were not felt in the past or could be accomodated due to the lower population densities, low resource use etc. However now with greater population densities, industrialization and accelerated agricultural development, the effects of the human activities are felt in terms of environmental damage and resource depletion. Thus this type of detailed study would be useful in the present environmental set up of Sri Lanka to highlight the environmental problems so that action plans can be drawn up to overcome or mitigate these problems.

This study initiated by the CEA would focus on problems which would be peculiar to a particular district and would therefore require action plans drawn up taking into consideration the particular district. It would also bring out problems of a more general nature, problems not restricted to this district alone — problems for which action plans would have to be drawn up in consulation with the institutional framework of other districts.

Environmental problems could arise due to natural causes or due to human activities. Whatever the origin of the environmental problems be, man's intention should be to identify the problems and overcome these adequately so as not to destroy the resource base and to preserve the environment for sustainable development. It is very important that man's activities go on without ecodisasters (Tolba 1977) or in other words development should go on without destruction. This goal can be achieved through proper environmental management.

Even though there is an urgent need for environmental management in Sri Lanka, there are only a very few laws which are essentially environmental in character (Wijayadasa and Ailapperuma 1986). These are the National Environmental Act No. 47 of 1980, Coast Conservation Act No. 57 of 1981 and the Natural Resources, Energy and Science Authority Act No. 54 of 1981. The National Environmental Act deals with the environment in Sri Lanka in its totality and not on a fragmented basis. Its primary concern is the establishment of management policies and institutional arrangements for the environment. This law makes provision for the protection and management of the environment and for the establishment of the Central Environmental Authority. On the recommendation of the CEA, the Government has made Environmental Impact Assessment mandatory for all development projects both of the public and private sectors with effect from 1st January 1984. However this has not been operating as it was envisaged, since the CEA at present plays a co-ordinating and a policy making role and does not have any

administrative and regulatory role (Wijayadasa and Ailapperuma 1986). Thus in Sri Lanka there has been and there still is a considerable extent of unplanned development leading to environmental deterioration.

In some districts of Sri Lanka people are aware of the environmental problems and these are brought to the notice of representatives of the District Environmental Agency chaired by the G. A. of the district. A few government officials too are aware of the importance of incorporating environmental considerations to development efforts through programmes initiated by the CEA. Thus in Sri Lanka the level of environmental awareness among people is very variable and therefore the steps taken to control environmental degredation is sometimes wholely lacking or very meagre.

Therefore this project was carred out

(1) to identify the basic environmental problems of the district.

(2) to identify the existing methods of environmetal management.

(3) to identify problems that need protection or mitigation and to draw up initial action plans where ever possible.

(4) to make recommendations for immediate, short term and long term implementation.

CHAPTER 2

SETTING AND BASE DATA OF DISTRICT

The Kalutara district is located in the Western province and is bordered by the Colombo district on the north, Ratnapura district on the east, the Galle district on the south and the ocean on the west as seen in figure 1.

This district has a total land area of 1615.5 sq. km. (623.9 sq. miles) of which inland waters account for 8.4 sq. km. (3.6 sq. miles). The topography of the area is indicated in figure 2. About 50%of the district being under 200 ft., about 99% being under 1500 ft. and only about 1% being over 1500 ft. The highest elevation of the district is at Haycock 2167 ft.

The district has three major rivers, the Kalu ganga, the Panandura ganga and the Bentota ganga (figure 3 . Of these, two rivers the Panadura ganga and the Bentota ganga serve as part of the district boundary. There are several lakes of which the Bolgoda lake is quite extensive and is shown in figure 3.

The average annual rainfall in the district is around 3233.6 mm. This has been calculated from the totals for 1951–1980 for rainfall stations of Kalutara, Milewa, Bandaragama, Halwatura and Geekiyanakanda Watte obtained from the Metereology Department of Sri Lanka. The rainfall in the four main seasons calculated using the monthly totals of the above stations are as follows:

March–April	Convectional	15.2%
May–September	Southwest Monsoonal	43.8%
October–November	Convectional, Cyclonic, Depressional	25.5%
December–February	Northeast Monsoonal	15.5%

The maximum rainfall for the district is received during the southwest monsoonal season.

The temperature records of the Bombuwela Rice Breeding Station for eleven years (1977–1987) give an idea of the temperature condition of the district. The average annual temperature of the district is around 30.6° C and the monthly averages (from the above data) are indicated below.

J	F	M	A	M	J	J	A	S	O	N	D
30.7	31.0	31.9	31.6	31.3	30.4	30.0	29.9	28.8	30.4	30.5	30.7

The district was divided into ten AGA divisions till December 1987. The ten AGA divisions are shown in figure 4 and the area of each division is indicated in table 1. The AGA division of Agalawatte has the largest area and Panadura the smallest area.

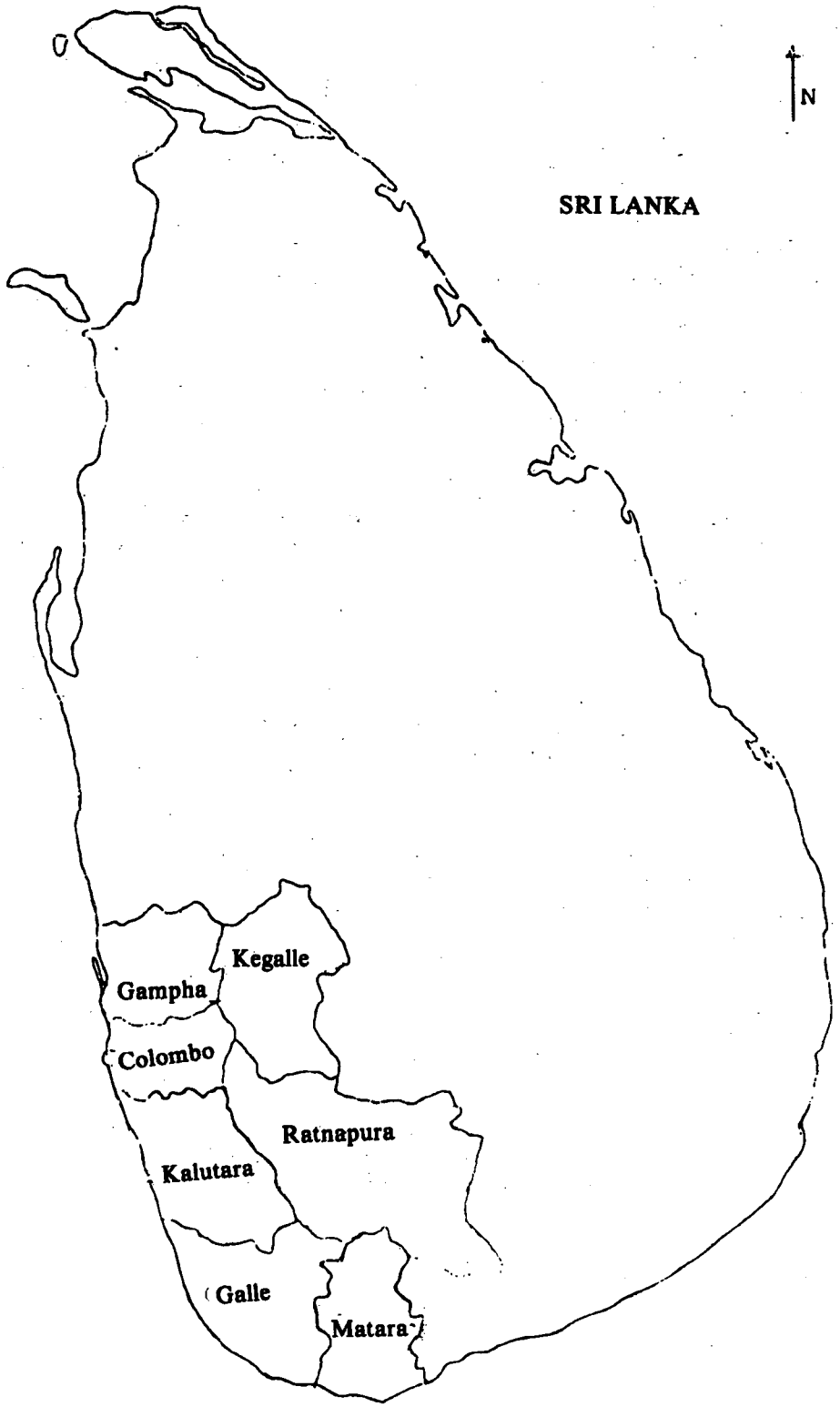


Figure 1 – Location of the Kalutara district

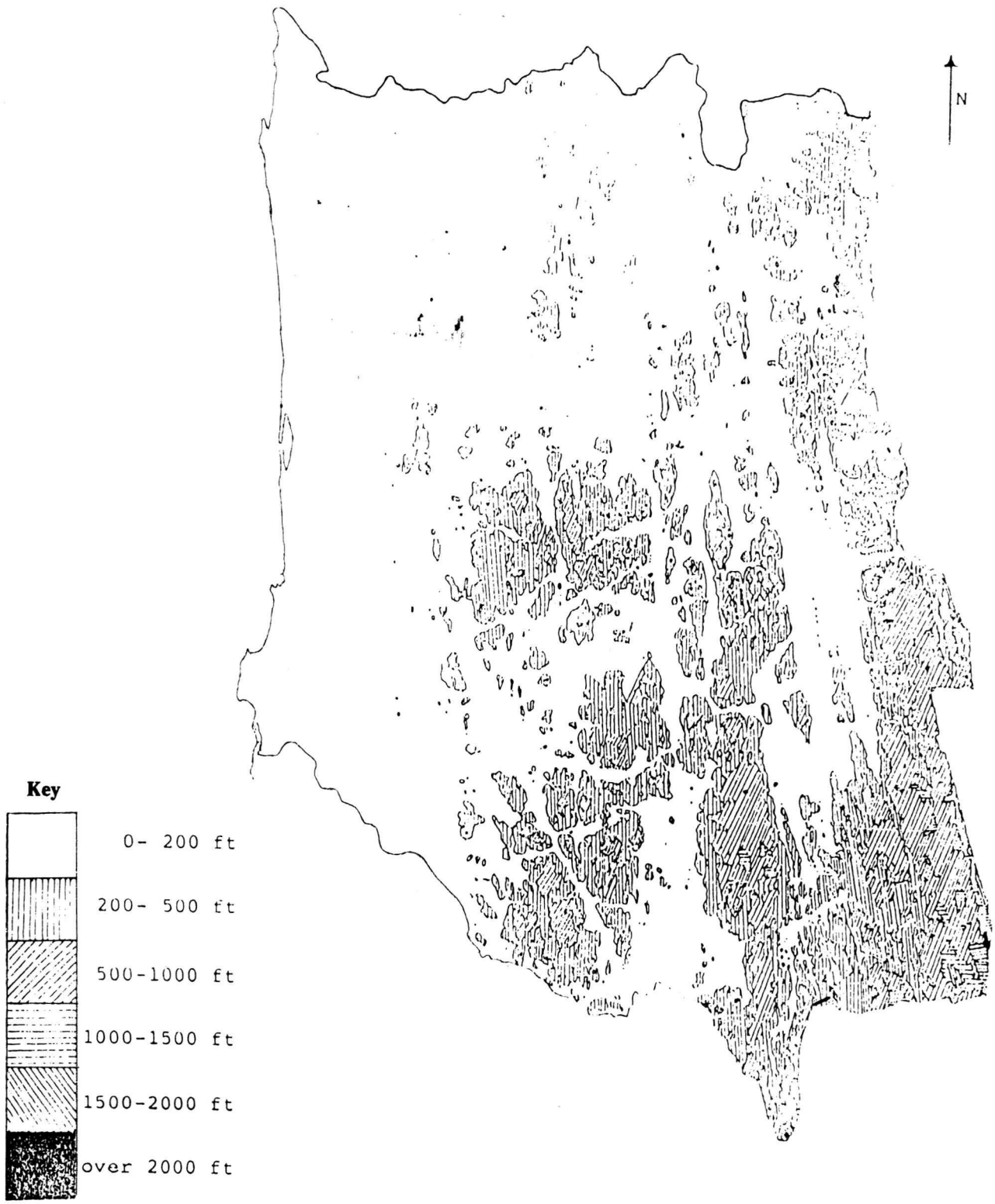


Figure 2 – Topography of the Kalutara district

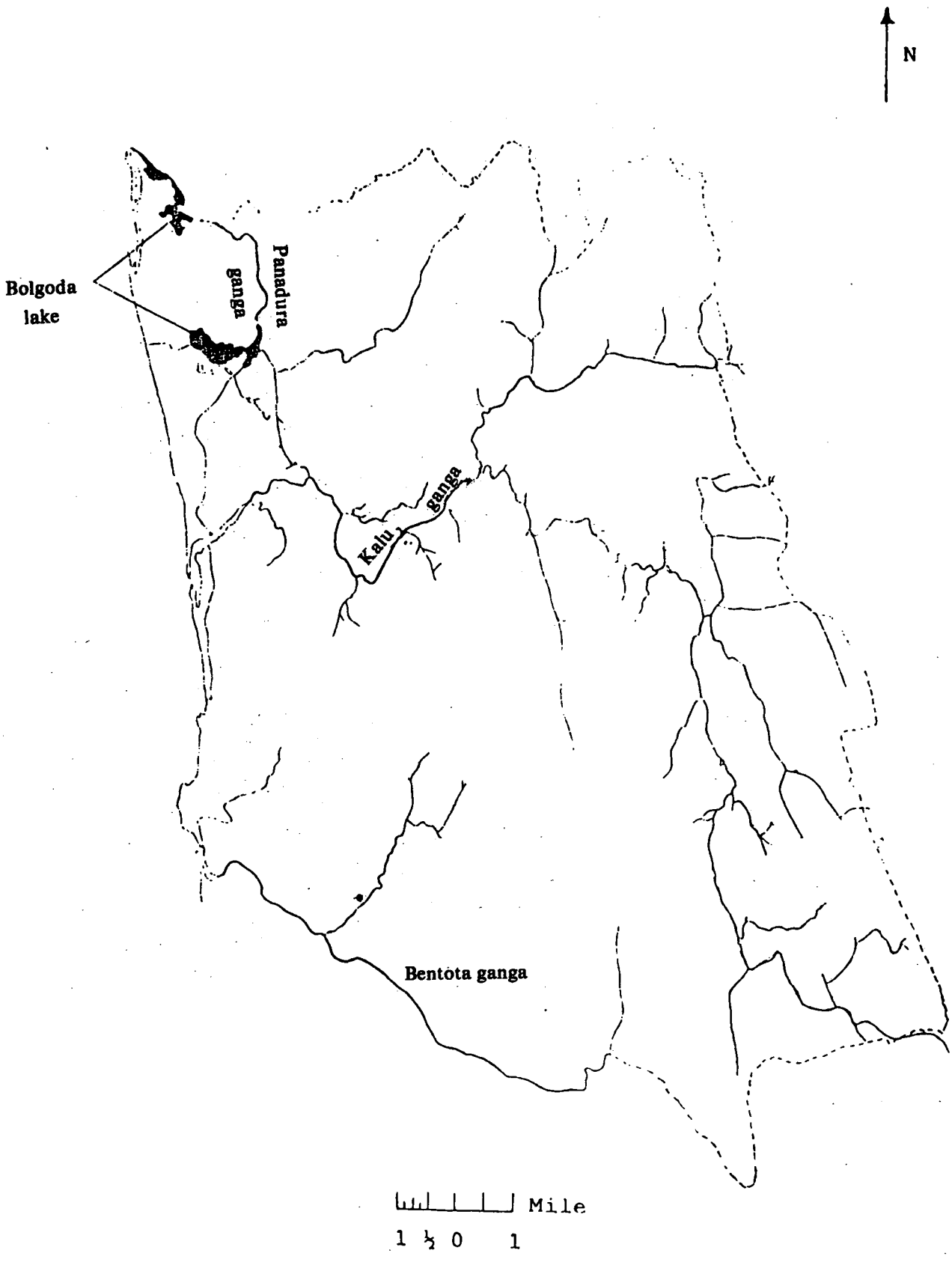
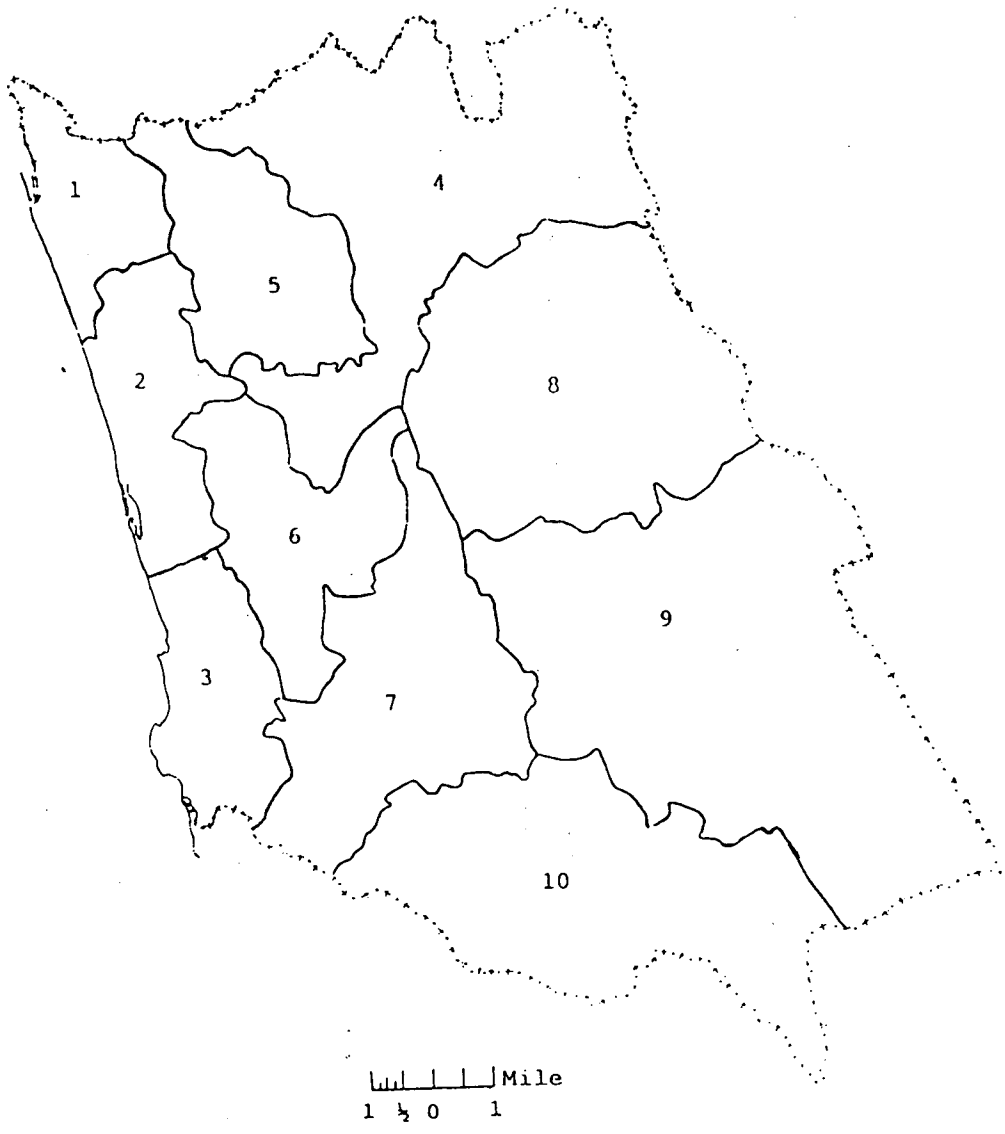


Figure 3 – Major rivers of the district



district boundary
AGA division boundary

1. Panandura
2. Kalutara
3. Beruwela
4. Horana
5. Bandaragama
6. Dodangoda
7. Matugama
8. Bulathsinhala
9. Agalawatta
10. Walallawita

Figure 4 – AGA division of district till December 1987

Table 1

Area Population and Population density per sq. km. of AGA divisions of the Kalutara district.

AGA division	*Area in sq.km.*	*Population*	*Population density per sq.km.*
Agalawatte	374.3	69,619	186
Bandaragama	93.2	62,184	667
Beruwela	70.4	111,479	1584
Bulathsinhala	241.6	62,649	259
Dodangoda	115.3	43,817	380
Horana	264.2	122,846	457
Kalutara	68.1	111,928	1644
Matugama	109.3	62,566	572
Panadura	59.6	137,694	2310
Walallawita	210.6	44,922	213

In January 1988 the district was divided into eleven AGA divisions — the new AGA division being Madurawela shown in figure 5.

The Kalutara district has an average population density of 514 persons/sq.km. (Sri Lanka Census of Population and Housing 1981), a density less than 1/5th of the adjoining Colombo district. The distribution of people within the district is quite uneven and in shown in figure 6. Extremely high concentrations of over 4500 persons/sq.km. are found in the urban areas of the Panadura UC, Kalutara UC, Beruwela UC, and Horana UC. The population is also concentrated along the narrow coastal belt of the AGA divisions of Beruwela, Kalutara and Panadura. The population density thins down from the coastline towards the interior. More than half of the district included in the AGA divisions of Dodangoda, Bulathsinhala, Agalawatte and Walallawita are entirely rural and are much less densely populated with less than 600 persons/sq.km. It should be noted that in Kalutara the urban population of 21.4% of 1981 has remained almost uniform from the level of 21.9% it was in 1971.

The people in Kalutara are predominantly Sinhalese (87.2%). Moors from the largest minority of 7.4% while Indian Tamils constitute 4.1% and Sri Lanka Tamils 1.2% of the population of the district. The religious composition reflects the enthic composition with 84.3% Buddhist, 7.6% Muslims, 4.5% Hindus and 3.6% of Roman Catholic and other Christians.

According to the Sri Lanka Census of Population and Housing report 1981, 56% of all houses of the district are permanent buildings built of durable materials, a little over 1/3rd of the houses are of a semi-permanent nature built with a mixture of durable and non-durable materials. Under 5% of the houses are improved units with cadjan roofs, low quality timber walls and mud floors.

A considerably high proportion of the houses 41%, are provided with flush or water seal toilets. 23% of the houses do not have toilets of any type.

In the Kalutara district rubber is the major agricultural crop followed by paddy, coconut and tea. The acreages under the major agricultural crops as given in the Sri Lanka Census of Agriculture 1982 general report are indicated in table 2.

Table 2

Acreages under major agricultural crops.

Crop	*Area under crop in acres*
Rubber	117,700
Paddy	41,082
Coconut	30,536
Tea	11,130

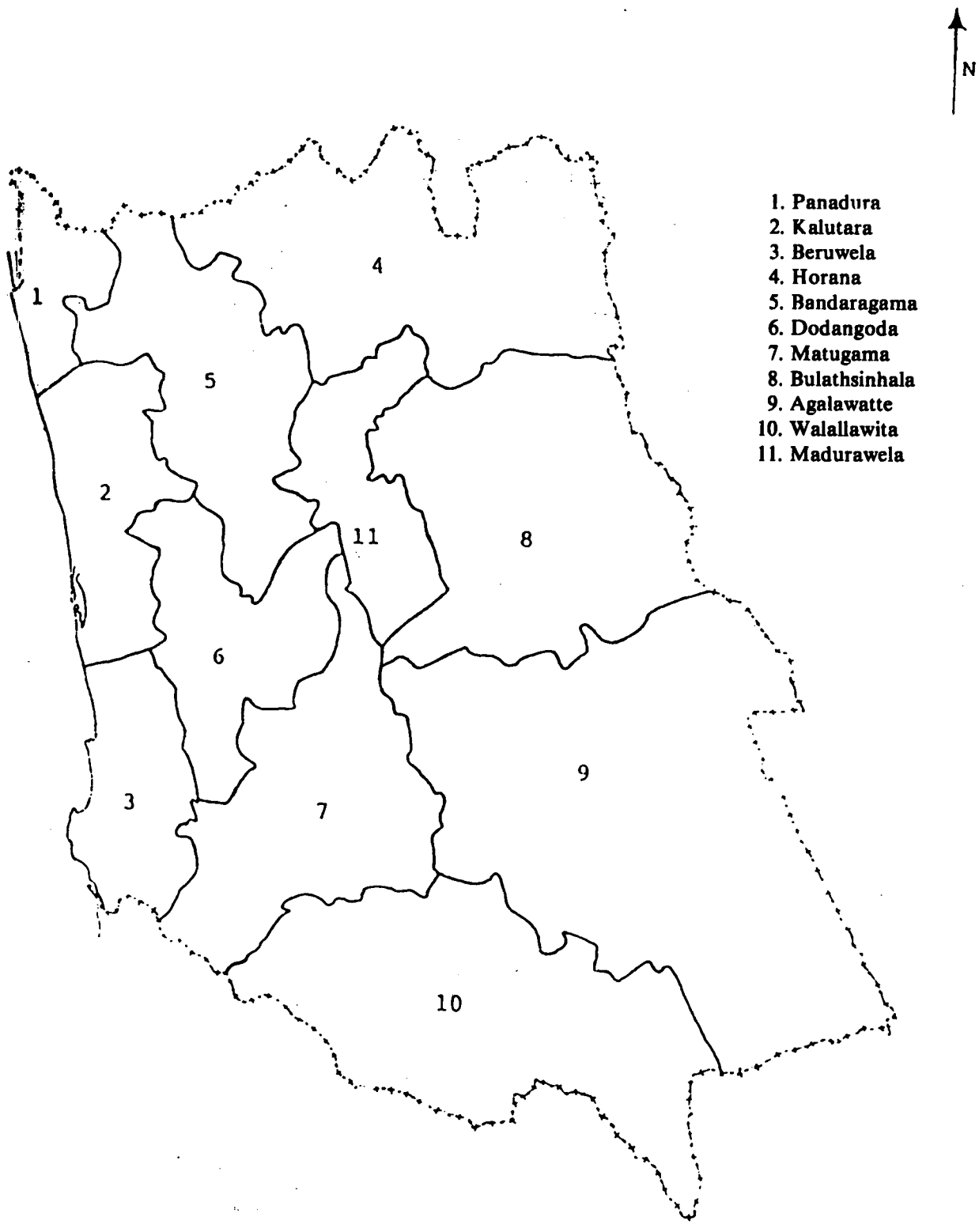


Figure 5 – AGA divisions of district after December 1987

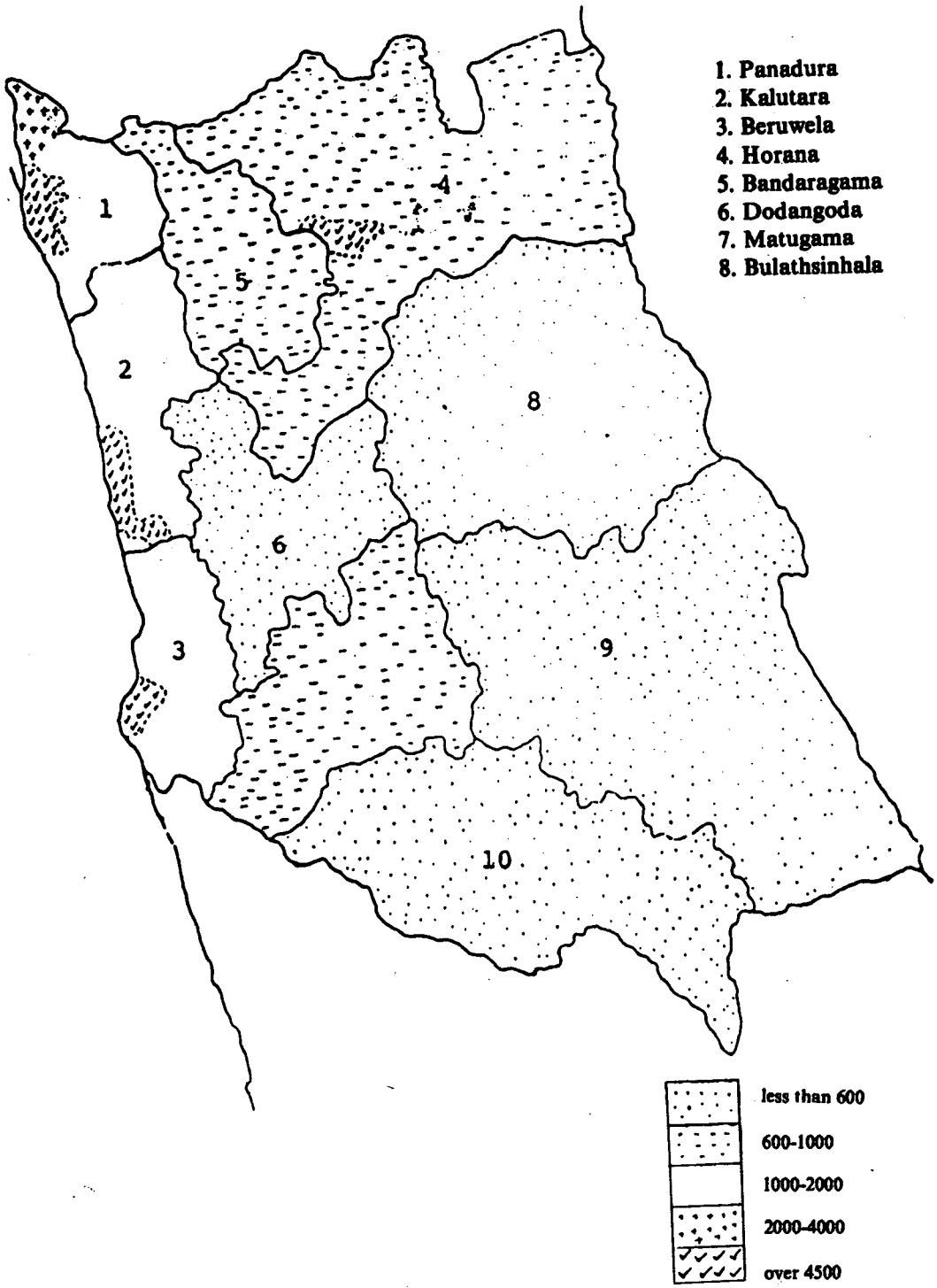


Figure 6 – Density of population in Kalutara district

CHAPTER 3

METHODS ADOPTED TO CARRY OUT THE PROJECT AND THE ENVIRONMENTAL PROBLEMS REPORTED FOR THE KALUTARA DISTRICT

The AGA division was considered as the unit of study for the preliminary investigation of the environmental problems of the district. Since the district had 10 AGA divisions at the initiation of the study in July 1987, and since an AGA has not been appointed to the new AGA division of Madurawela created in January 1988 and no data is available for the new AGA division created, the project would be discussed in relation to the ten AGA divisions shown in figure 4.

Work was carried out with the help of the District Environmental Agency of the Kalutara district in which all AGA divisions are represented. Working through this Agency a general idea of the environmental problems of each of the AGA divisions and those of the district as a whole was obtained. Initially an introduction to the problems of the Kalutara district was obtained by attending a meeting of the District Environmental Agency. After this eye-opener meeting where the environmental problems of each AGA division were highlighted, work was initiated through the AGA's of the divisions in which problems had been reported. Visits were made to the sites or projects which were causing environmental problems, with the AGA or after prior permission had been obtained by the AGA. At the project sites details of the project causing environmental deterioration were obtained and discussions were held with the people in the vicinity and the developers (when available) to determine the type and magnitude of the problems reported.

After these preliminary investigations the environmental problems that needed special protection/mitigation measures were identified from those problems that could be solved by management alone without any particular treatment process. After this identification, site examinations were carried out and more discussions were held with the developers to determine whether any protection or mitigation measures were already installed or planned to overcome the problems. When such protection or mitigation measures were already installed these were studied to determine if they were adequate to overcome the problem. Where plans were designed and were available, these were studied and the people who designed these were met to find out information of design and fabrication and to determine the efficiency of tackling the particular problem. When such protective measures or plans were not available or what was available was inadequate, possible methods were examined to reduce the environmental damage. Thus from the fifth month onwards effluents were collected from some of the projects causing environmental problems and laboratory analyses were made and basic mitigation measures were designed and tested out on a laboratory scale.

In addition to these whenever a general problem common to the entire district was noticed, the institutions or district offices handling these sectors (eg. Forestry, Irrigation etc.) were visited and information was obtained. However more, information was obtained from the offices in Colombo.

At the District Environmental Agency meeting environmental problems were reported for the AGA divisions of Panadura, Kalutara, Horana, Bulathsinhala, Agalawatte, Matugama and Walallawita and not by Dodangoda, Bandaragama and Beruwela. The problems that were highlighted at this meeting and other problems identified later are given below and where possible are indicated in figure 7.

Agalawatte
1. Deforestation

Beruwela
1. Sea Erosion
2. Discharge of distillery waste from Beruwela and Moragalle distilleries.

Bulathsinhala
1. Discharge of waste from Chris Thombo farm.
2. Discharge of serum from rubbber estates.
3. Erosion of stream banks due to removal of sand and loading/unloading of logs.

Dodangoda
1. Air pollution due to stone crushers.

Horana
1. Discharge of serum from rubber estates (Ellekande and Sorana gp.)
2. Discharge of rubber serum from C. W. Mackay Ltd. at industrial estate and Sherman and Company.

Kalutara
1. Flooding.
2. Sea erosion.
3. Air pollution due to burning of rubber scrap and lead fumes in Associated Motorways Ltd.
4. Discharge of distillery waste from distilleries at Wawulugala and Malegoda.

Matugama
1. Discharge of serum from rubber estates (Deniston and Yatadola).
2. Disposal of waste from market.
3. Water contamination due to sewage.
4. Deforestation.
5. Erosion and landslides.

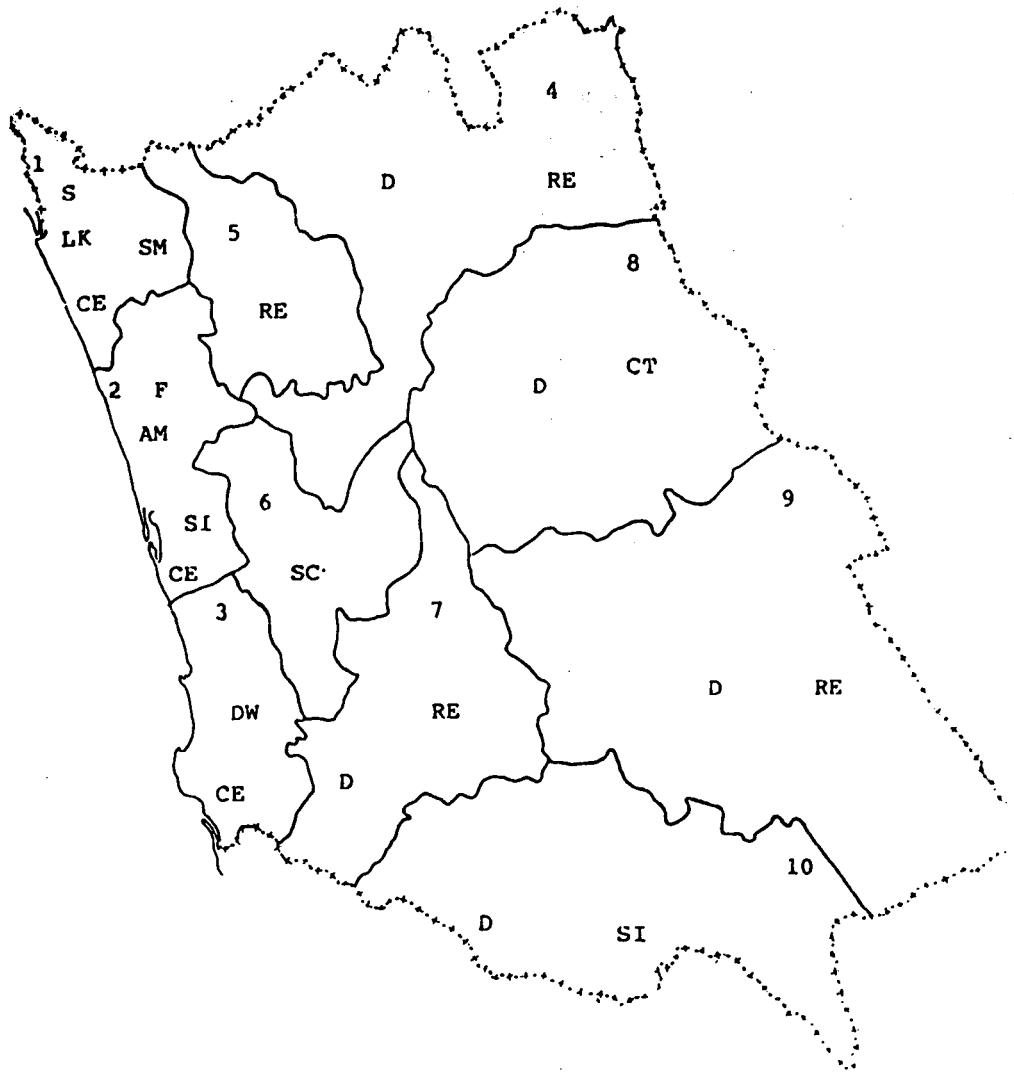
Panadura
1. Accumulation of saw dust in saw mills at Horetuduwa.
2. Discharge of slaughter house waste at Sarikkamulla.
3. Smoke from lime kilns at Pallimulla.
4. Filling up of low lying area at Moderawila.
5. Silting up of Talpitiya canal and other irrigational canals.

Walallawita
1. Salt water intrusion into paddy fields.

On examing the problems highlighted above it is seen that some are peculiar to the particular location like the coastal problems even though reported from certain AGA divisions only, could most likely exist in the other AGA divisions as well and are thus not location specific.

On site examination it was found that some of the problems reported did not produce polluting by-products and hence did not need any special treatment facilities. These problems could be solved by management of the waste i.e. by improving the disposal or by utilization of the waste. Thus the problems reported could be grouped in two categories — those that needed special treatment facilities and those that did not need any treatment facilities but could be solved by management of the wastes generated. Out of the problems reported those which did not need any treatment facilities are:

1. accumulation of saw dust from saw mills.
2. waste from market.
3. water contamination due to sewage.
4. filling up of low lying areas
5. deforestation
6. erosion and landslides



Mile
1 ½ 0 1

1. Panadura
2. Kalutara
3. Beruwela
4. Horana
5. Bandaragama
6. Dodangoda
7. Matugama
8. Bulathsinhala
9. Agalawatta
10. Walallawita

AM - Associated Motorways and pollution
CE - Coastal erosion
CT - Chris Thombu farm waste
D - Deforestation
DW - Distillery waste
F - Floods
L - Landslides
LK - Lime kilns
RE - Rubber effluent
S - Slaughter house waste
SC - Stone crushers
SI - Salt water intrusion
SM - Saw mills

Figure 7 - Environmental problems of the AGA divisions of the district.

7. erosion of stream banks
8. sea erosion
9. flooding
10. salt water intrusion

The problems that needed special treatment facilities are:

(1) discharge of rubber serum
(2) discharge of distillery waste
(3) discharge of farm waste
(4) air pollution due to burning of rubber scrap
(5) air pollution from lime kilns
(6) air pollution from stone crushers

Some of these problems which did not require any treatment facility like saw mill waste, waste from market and land filling would be dealt with in one chapter while the other problems would be dealt with in separate chapters. Sometimes related problems are discussed together for eg. deforestation, erosion and landslides.

At the end of each chapter dealing with environmental problems, immediate, short term and long term recommendations would be given where ever possible to overcome or mitigate the problems discussed. In addition to these recommendations, general recommendations applicable to the district would be given in the last chapter.

CHAPTER 4

ENVIRONMENTAL PROBLEMS THAT COULD BE OVERCOME BY IMPROVEMENT OF THE METHODS OF DISPOSAL OF WASTE

Kalutara district has several environmental problems which could be overcome without any special treatment processes by improving the methods of disposal of waste. This chapter deals with four such problems Saw mill waste, Solid waste, Land filling and Water contamination due to sewage.

Saw mill waste

Saw dust a by product of sawing of timber in saw mills, has been reported to create environmental problems in the Kalutara district. Even though it has been reported only from the AGA division of Panadura, this problem is in existence in other AGA divisions of Kalutara too. The saw dust generated from these mills is generally considered as waste and is dumped in the direct surroundings of the mills or burnt. Huge piles of smouldering saw dust are usually seen in the premises of the mills.

In the AGA division Panadura saw mills are located at Horetuduwa bordering the Panadura ganga. Here the saw dust is being dumped onto the banks of the river. The problems created are not very disturbing at present but if it goes unchecked it would lead to the narrowing of the river. The saw dust when disposed of in this manner accumulates especially because the movement of water is slow. Once the say dust accumulates on the banks these are colonised by plants and made somewhat stable. With time this type of accumulation could interfere with the movement of boats and barges along the river. Depending upon the type of timber sawn, toxic substances could be released from the saw dust to the water which could have harmful effects on the organisms in the water courses. This could affect the fish and prawn industry of this area.

Saw dust in its natural form is a very bulky material with a relatively low heating value, a high moisture content (varying from 30% to 60% of its weight). 1kg. of dry saw dust has a heating value of almost 20 Meg Joule comparable with about 0.7 kg. of coal, about half a litre of fuel oil, or 0.5 cubic meters of natural gas (Arends and Donkersloot-Shouq 1985). 2kg. of saw dust will generally give 4 to 5 hours of good cooking fire.

Since saw dust is a bulky material it involves high transport and storage costs. A method to obtain a more profitable product and to improve its retail value is to compress saw dust into briquets. Saw dust briquets are easy to light, give adundant heat in a short time and are very clean (Arends and Donkersloot-Shouq 1985). The more expensive the other fuels are, the more economical it will be to make briquets of saw dust. The briquets must have a sufficient toughness to withstand exposure to weather and shocks during transportation. It should not disintegrate on exposure to heat during combustion.

The TOOL foundation (Technical Development Developing Countries) CICAT (Centre for International Co-operation and Appropriate Technology) and CICA (Committee for International Co-operation Activities) have made a survey of the possible uses of saw dust in developing countries in 1985. This provides information on various uses for which saw dust could be put to, They are fuel from saw dust, agricultural uses of saw dust, saw dust in building material, saw dust in chemical industries and miscellaneous uses of saw dust.

Saw dust has been used in Sri Lanka for various purposes eg. for domestic cooking (Wijesinghe 1983), for the deep litter poultry system and on a smallar scale as a fertilizer and soil conditioner.

The saw mill owners do not realise that disposing of the saw dust as they do at present along water courses would create any problems. Hence they allow the saw dust to accumulate along the water courses without trying to dispose of the waste in another way.

Recommendations for Protection/Mitigation

The saw mill owners should be made aware immediately of the environmental problems they cause. They should be requested to remove the saw dust from the premises without disposal in this haphazard manner.

Extra efforts should be made to promote saw dust for domestic cooking since this would be an easy way to get rid of the saw dust. People in the locality of the saw mills should be pursuaded to use saw dust for cooking. Methods should be worked out to improve the type of cooker and the heat provided by saw dust for cooking.

The Central Environmental Authority should obtain the assistance of various government departments and agencies to study some of the uses of saw dust given in "An overview of the possible uses of saw dust" (1985), and report on the suitability and cost effectiveness for Sri Lanka. This information should then be passed on to the mill owners who would then know how to make the saw dust useful without considering it a problem source. Saw mill owners should be made to initiate these projects using saw dust. After this information is made available dead lines should be set by the CEA so that unless haphazard disposal is stopped with 10 years from that time, penalties would be imposed.

Solid Waste

Another problem that could be solved by improving the disposal methods is the problem of solid waste. Although this problem has been reported from the AGA division Matugama this could apply to all AGA divisions in Kalutara.

Solid waste or refuse is produced in every house and in every establishment. It is estimated that a person produces from half to one kilogram of refuse daily. Much of this is garbage of thrown away food which is putrescible and is food for many insects, rats and other scavengers. It attracts a variety of insects and rats which feed on it and breed in it. In warm climates exposed garbage has been found to produce as many as 70,000 flies per cubic foot of garbage per week (Herath 1988). Mosquitoes also breed in refuse dumps. Rainwater accumulating in discarded tins, coconut shells, bottles and tyres provide breeding sites for *Aedes aegypti* the vector of Dengue Haemorrhagic fever. The dirty pools of water in rubbish heaps are effective breeding sites for *Culex quinquefasciatus* the vector of filariasis. Thus the improper disposal of domestic wastes creates an ugly sight and also provides breeding sites for many disease vectors. Therefore proper disposal of domestic waste is very important for the safeguarding of the health of the community.

In rural areas refuse can be conveniently disposed of by burning. Composting or where waste can be recycled for use as a fertilizer is another useful method for disposal of waste.

In urban areas however individual methods of waste disposal becomes impracticable due to limitations of land and the collection and disposal of waste becomes the responsibility of the local authorities. The disposal of refuse is mainly by sanitary land fill.

In the Kalutara district (and in Sri Lanka too) disposal of waste from hotels, shops, boutiques, markets and other trade stalls and domestic waste is done so haphazardly that no place is considered unsuitable to dump the waste. The owners of these establishments feel that the road or the drains or anywhere is suitable for getting rid of the wastes generated. It is felt that where ever the wastes are dumped it should be removed. No thought is given to whether it is hygenic or whether it leads to breeding grounds for pests or whether it leads to breeding grounds for flies and mosquitoes. The only criterion seems to be to go on till the authorities stop it!.

This problem even though it has been highlighted from the Matugama AGA division is present in all AGA divisions of the district. This is especially felt in areas where the surface drains are in a dilapidated condition. When garbage is thrown into such drains, collection becomes difficult and this causes obnoxious smells and the drains become breeding grounds for mosquitoes and flies.

For the Kalutara district waste collection is carried out by the urban/town councils for areas coming under these authorities. For example for the Kalutara AGA division there are about a hundred labourers working on waste collection and disposal is done at two locations - one at Nagoda a public dumping ground 6 acres in extent, and the other a private dumping ground at Kalutara north. For areas not coming under a urban/town council i.e. for VC areas, labourers are allocated for waste collection from areas where shops are located. Thus for all AGA divisions the infra structure is therefore waste collection and waste disposal. In addition to these, for the Matugama AGA division due to the dilapidated condition of the surface drains and the problem of waste collection, the MOH office has issued a directive to all traders to keep dust bins in their business establishments.

Recommendations for protection/mitigation.

What is necessary for this district is the proper collection and disposal of waste in a hygenic manner. It is recommended that immediate steps should be taken to repair the surface drains where ever they are in a dilapidated condition. The introduction of covered waste bins advocated by the MOH office Matugama should be extended to other AGA divisions as well. If these are not introduced within a few months high penalties should be imposed on those who dump their waste in the open. To check on whether this is done properly, the existing unsightly garbage dumps in all AGA divisions should be intially removed.

The present practise of mere dumping of waste in the dumping ground should be stopped. A layer of soil should be added over the refuse at least every 3 or 4 days. It should also be pointed out that it is not the lack of knowledge of the methods of hygenic disposal that lead to the present practice, but the lack of commitment to the cause. Waste disposal is done in the hygenic manner when there are competitions among the AGA divisions. Hence the authorities should be briefed on the importance of proper waste disposal at all times and the problems caused by poor waste disposal, so that additional funds could be estimated for such type of work where necessary.

Land Filling

The probelm of waste disposal is connected with the filling up of low lying areas. In the AGA division of Panadura, the low lying area of Moderavila has been filled up with the garbage collected by the urban council. It has been levelled with the addition of soil. However even after the filling has been completed waste is being dumped here causing problems to the people in the neighbourhood. This is not the problem that is worrying the people here. The problem is that with the low lying areas getting filled up, the rain water from the neighbourhood has no way of draining out and thus the houses and the land in the adjoining areas go under water.

Recommendation for protection/mitigation

When low lying areas are filled up, it should be done after proper planning taking into consideration the neighbourhood. Certain sections should be left without filling to enable the water from the surrounding areas to drain and escape during the rainy season. The people living at present around the filled up low lying areas of Moderawila should be given assistance both in money and methodology to drain their land during the rainy season into the canal nearby.

Water contamination due to sewage

This problem has been reported from the AGA division of Matugama but it could be present in all divisions of Kalutara.

At present the water supply to the Kalutara district is from three sources.

1. pipe borne water from the Kalu ganga.
2. pipe borne water from Kalatuwawa/ Labugama.
3. from local supply wells and rivers and water courses.

To supply pipe borne water from the Kalu ganga there is a pumping station and a treatment plant at Thebuwana. This water is being supplied from Wadduwa to Bentota for the coastline AGA divisions. The supply for the Panadura AGA division comes from Kalatuwawa/ Labugama. The contamination of water with sewage usually does not arise in the case of pipe borne water. It arises when the supply comes from wells, rivers and water courses directly. The problem of sewage contamination occurs:

1. due to the improper siting of latrines and wells
2. due to man not using latrines for defaecation.

According to the Census of Population and Housing report in 1981, 23% of the houses in the district do not have toilets of any type.

Recommendations for protection/mitigation

Even though legislation exists for the siting of latrines and wells, these are sometimes not strictly adhered to especially when buildings are located very close to one another. Hence there should be more strict checks when plans are passed by the Urban councils or any other authority responsible for granting permission. Also unauthorised housing should not be allowed as here toilets are not even thought of!

CHAPTER 5

DEFORESTATION AND LANDSLIDE HAZARD

This chapter considers two environmental problems of the Kalutara district which are related to one another deforestation and the lanslide hazard.

Deforestation is an environmental problem that has been reported from the AGA division of Matugama and Agalawatte. Deforestation however is not a problem confined to these AGA divisions alone but is a problem for the whole of Sri Lanka. Abeywickrama (1986) reports that at the beginning of the century Sri Lanka had about 70% of the land under forest, by 1956 this had come down to 44% and now is estimated to be below 24%.

Forests have multiple uses. They have protective, regulative and productive functions at the ecosystem level (Tropical Forest Ecosystems 1978). The protective functions are 1) soil protection by absorption and deflection of radiation, precipitation and wind, 2) conservation of humidity and carbon dioxide by decreasing wind velocity and 3) sheltering and providing required conditions for plants and animals. The regulative functions are 1) absorption, storage and release of carbon dioxide, oxygen and mineral elements, 2) absorption of aerosols and sound, 3) absorption, storage and release of water, and 4) absorption and transformation of radient and thermal energy. The productive functions are 1) efficient storage of energy in utilizable form in phyto and zoo mass. 2) Self regulating and regenerative processes of wood, bark, fruit and leaf production 3) production of a wide array of chemical compounds such as resins, alkaloids, essential oils, latex and pharmaceuticals.

Even though forests have multiple uses, the importance of forests have been mainly looked at from the productive aspects for the production of commercial timber and fuel wood. The importance of forests for protective and regulatory functions have not been given the required emphasis. In a predominantly agricultural country like ours maintaining forests for protective and regulatory functions should receive priority over commercial production. Hence it is very necessary that where ever possible forests should be left undisturbed —greater protective and regulative functions being achieved when the forest is left in the undisturbed state. Sometimes however to set aisde forests for protective and regulatory functions is not possible since there is a growing demand for timber, land for settlements and growing agricultural crops.

The forests of the Kalutara district are of the lowland wet evergreen type. When undisturbed the forests show the typical storeyed appearence with a canopy, sub canopy and sometimes an emergent layer. The forests of Morapitiya, Yagirala and Kalutara are typical examples of the type of forest found in the district.

Data on the forests of the district was obtained from the Divisional Forest Office, Kalutara. More recent data however was available in the Forest Dept., Colombo for 3 electorates of the district Agalawatte, Horana and Bulathsinhala (covering the AGA divisions of Horana, Agalawatte, Bulathsinhala and Walallawita) where an Integrated Rural Development Project is in operation. These figures will be presented here since they are a good representation of the areas where forests are present in the Kalutara district to obtain some idea of the extent of deforestation. Even though there are 4 categories of forests in Sri Lanka, only data relating to forest reserves (table 3) and proposed reserves (table 4) will be presneted here.

Table 3.
Extent of reserved forest in forest department records and present estimated extent in acres.

Reserved forest	*Extent in records in acres prior to 1960*	*Present estimated extent in acres*
Haycock	894	819
Ingiriya	868	353
Kudaganga	349	100
Mahagama	911	550
Kirigala	46	46
Pelwatte	271	–
Yagirala	7449	5000

Table 4
Extent of proposed reserves in Forest Department records and present estimated extent in acres

Proposed forest reserve	*Extent in records in acres prior to 1960*	*Present estimated extent in acres*
Botale PR	682	–
Delmella-Yatagapitiya PR	5,025	1,000
Divalakanda PR	694	–
Kurana-Madakada PR	354	–
Kalugala PR	11,441	7,198
Lathpandura PR	103	–
Morapitiya-Runakande PR	17,176	14,207
Meegahatenna PR	696	160
Neluketiya Mukalana PR	6,486	3,680
Wagawatte PR	354	–
Yagirala PR	84	84
Pelenda West PR	359	–
Polwatte Kande PR	72	–

From tables 3 and 4 it can be seen that forests of the district are being lost at an alarming rate. Sometimes the entire forest reserve (eg. Pelawatte) or a proposed reserve (eg. Lathpandura) may not be there. As in the case with all wet zone forests, the forests of the Kalutara district too are subject to disturbances by man. Sometimes forests have been lost due to encroachment. The encroachments are done mainly because of the need for land for settlements and growing agricultural crops. Thus in addition to building dwelling houses, the people who encroach grow tea, rubber and passion fruit which provide good cash returns.

In the AGA division of Agalawatta and Walallawita the total extet of state forests prior to 1960 was 41,504 acres. The present extent is 28,687 acres. Thus during the last 28 years the forest has been depleted by 30.9%. The percentage of land area under forest cover is 20%. About 50% of the encroached land has been put under tea, rubber and cinnamon. The balance area is under agricultural cash crops and homesteads.

In the AGA division of Bulathsinhala the extent of state forests prior to 1960 was 14,272 acres and at present it is 5380 acres. Thus during the last 28 years the forests have been depleted by 6.2%. The percentage of land under forest cover in Bulathsinhala is 9%.

In the AGA division of Horana too the forests have been depleted from 4750 acres prior to 1960 to 2775 acres at present. Thus the forests have been depleted by 41.5% during the last 28 years. Since in Horana the urban development is high, the land area under forest is only 8.2%.

To overcome the problem of deforestation, forest plantations are being raised by the Forest Department. Most of the plantations are small in extent below 25 acres. However there are large plantations too — the largest are about 65 plantations for the 4 AGA divisions. The species used in the forest plantations are *Pinus caribaea, Alstonia, Albizzia, Swietenia, Eucalyptus deglupta.* In a few plantations indigenous trees are grown eg. *Dipterocarpus.*

The forest reserves and the proposed reserves indicated in tables 3 and 4 are not demarkated as protection forests. Also the large forest blocks of Morapitiya — Runakande, Yagirala, Kalugala and the forest plantations have been indentified as timber producing stands in the Forestry Master Plan 1986 (Jaakko Poyry International Oy.) Thus these forests will be managed on a selective felling basis for sustained yield.

In addition to the lowland wet evergreen forest, the mangroves also form an important natural community in the Kalutara district. The coastal communities within an area of 2 km. from the coastline have been mapped on a scale of 1:63,360 in 1986 by the Coast Conservation Department and is given in the sri Lanka coastal zone management plan 1987 and is presented in table 5.

Table 5
Extent in hectares of coastal habitats within 2 km. from the coastline of the Kalutara district.

Coastal habitat	*Extent in hectares*
Mangroves	12
Salt marshes	-
Dunes	4
Beaches	77
Lagoons	87
Other water bodies	476
Marshes	91

From these figures it is very clear that the amount of mangroves left in the Kalutara district is very meagre. Mangroves are exploited for use in construction of huts and fences, as stakes in fish traps or kraals in lagoons in the brush pile method of fishing and to dye nets and sails. Mangrove species which grow near the water assist in preventing soil being washed away by trapping soil and therefore help in building up the shore. Mangroves are very important for fish production. The majority of the coastal species in the region inhabit mangroves and estuaries during one or more periods in their life cycle. Thus the destruction of mangroves will have an adverse effect on the coastal fish production which is the backbone of the Sri Lanka fish industry. This is so even for the prawn industry.

According to the Coastal Environmental Management Plan for the West Coast of Sri Lanka (1985), the main cause of destruction of mangroves is land reclamation for human settlements and agriculture. The secondary effects of settlements such as urbanization and industrialization also cause destruction of mangroves. The discharge of toxic substances from factories and waste products such as saw dust and coir dust from saw mills and coir factories to lagoons (eg. Bolgoda lagoon) are some of the major hazards for mangroves.

Recommendations for protection/mitigation

In view of the protective and regulative functions of forests and also since in the Kalutara district there have been massive lanslides, effects should be made to preserve the natural forests that are left. Efforts should be made immediately to preserve as protection forests some of the forests identified as timber producing stands. When G.A.'s or political authorities request for the release of reserves proposed reserves these should not be allowed.

Forest plantations should be established where ever possible. The results would be obtained with the people's participation. Plans are already available with the Forest Department for the next five years for the establishment of forest plantations.

Enrichment planting would also be useful where the forest reserves and proposed reserves have been encroached upon. Plans are already available for such planting by the Forest Dept, within the next five years.

In Sri Lanka non governmental organisations have proved their worth in the protection of the environment. Thus for reforestation too the help of the NGO's can be sought. Already for the Kalutara district such reforestation programmes organised by the NGO's are available. An example would be the work carried out at Galahitiya by the Venerable Kiranthidiye Pannasekera Thera and his group Friends of Nature. Such projects seem very slow and unimportant to persons not familiar with forestry practices and tree growth. But it should be realised that getting corporation from the local people takes time, establishing seedlings take time and the terrain they work in is very difficult. So when such projects are initiated or plans are submitted for initiation of projects they should be given what ever support and encouragement possible through the Kachcheri.

The mangroves with their various uses and importance in the fishery industry should be protected. According to the figures of the Sri Lanka Coastal Zone Management Plan (1987) no large area is available at present. Therefore the extent of mangroves left should under no circumstances be released for human settlements etc. Also when mangrove species are removed for various purposes it should be done without destruction to the mangrove. As is done for lowland wet evergreen forests mangrove species could be planted round the reclaimed mangrove areas. These would then protect these areas and also help to build up the shore and with time offer the suitable habitat for some of the fish and prawn which come into the mangrove area sometime during their life cycle.

Landslide hazard

A problem related to a certain extent to the massive deforestation reported for the district is the landslide hazard. Kalutara district is considered to be a high risk area according to the Landslide hazard in Sri Lanka (1986).

For the Kalutara district 13 locations have been identified as posing varying degrees of landslides hazards. These are indicated in figure 8. Some of these areas represent areas of general instability and lie adjacent to past landslide locations. Other localities have widespread cracks on the terrain which with prolonged spells of rain may show large scale hazardous movement.

For each location an information sheet is available indicating the locational details, references to past occurence of landslides, reported damages, future risks and suggested remedical measures. The agencies who should act in each case have also been suggested.

The immediate measures suggested to prevent or mitigate future damages in Landslide hazard in Sri Lanka (1986) for the Kalutara district are:

(1) evacuation of houses located in landslide region

(2) stopping any further cutting on the foot of the slopes to build houses and also to prevent vertical cuts behind houses.

(3) Stoppage of unplanned cultivation on the slopes without a proper drainage system

(4) proper drainage of slopes

(5) cracks on the hills to be filled so as to prevent rain water entry

(6) loose rocks, large boulders have to be supported or shot blasted for easy disposal

(7) terracing, special grassing and reafforestation to increase stability

(8) holes left after removal of old rubber tree trunks to be closed up so as not to allow rain water pools to collect.

The steering committee for Land Use Planning on a suggestion made by the National Building and Research Organisation has decided to establish District Landslide Monitoring Units for the seven landslide prone districts of Sri Lanka. This unit would be headed by the GA of the district and would have the AGA (lands), an engineer each from the Buildings Department, Road Development Authority and Irrigation Department, Assistant Director of Agriculture, Assistant Director of Social Services, representative from the Janatha Estate Development Board,

Figure 8
Locations of landslide hazards in district
(from Landslide Hazard in Sri Lanka 1986)

Kalutara District	
Kitulgoda	KT-1
Sirikandura	KT-2
Dartonfield Estate	KT-3
Nagahenakanda	KT-4
Panthiya	KT-5
Bulathwathukanda	KT-6
Girikola Kandagalakanda	KT-7
Wettewa	KT-8
Udawela	KT-9
Kobawaka Kanda	KT-10
Kamburawela Labiyadokanda	KT-11
Helembe Estate	KT-12
Wandurebba	KT-13

representative from the Sri Lanka State Plantation Corporation and the District Forest Officer. A training programme has already been held (UNDP/UNCHS Training Programme 1988) to train, advise and guide the members of the District Landslide Monitoring Units on the technical aspects of landslide disaster management in March 1988.

Recommendations for protection/mitigation

Thus for the Kalutara district information on the landslide hazard and the suggested remedial measures are available. Also some officers from the departments likely to manage landslides have been trained. Therefore these officers should take immediate steps to implement the suggested remedial measures for kalutara and should be on the alert and watch out for any possible signs of landslides.

CHAPTER 6

FLOOD DAMAGE AND SALT WATER INTRUSION

A major natural hazard faced by the Kalutara district is the flood damage caused by the Kalu ganga. The Kalu ganga has the highest volume of discharge per year out of the Sri Lankan rivers (Irrigation Dept. 1974) The head waters of the Kalu ganga originate at an altitude of about 2243 m (7360 ft.) above sea level and flow along narrow 'V' shaped valleys with steep gradients (Madduma Bandara et al 1987). Due to the steep gradients of the upper reaches of the Kalu ganga, low lying areas experience floods during the rainy seasons. The seasonal distribution of rainfall in the catchment area is controlled by the two monsoons — the highest rainfall being received from the south west monsoon. A large portion of the railfall (about 77.7%) is discharged as run off in the basin due to its lay out relief and orientation. The south west monsoon season is associated with a high volume of discharge and during this season the Kalu ganga frequently overflows its banks and floods the surrounding low lying land. A land area of about 8000 hectares is generally affected.

Lowland agriculture is seriously impacted by frequent flooding and the farmers are reluctant to engage in high intensity agriculture in view of the potential losses due to flood damage. Urban and industrial land is also adversely affected by flooding. Brick manufacture in low lying areas is also adversely affected.

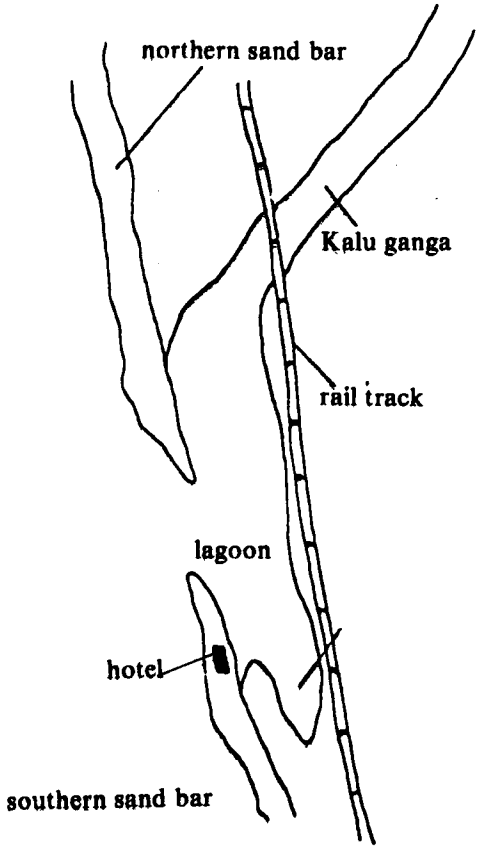


Figure 9 – Sand bars at Kalu ganga outfall

It is a common phenomenon that entrances to river estuaries and other waterways get partly or completely closed during periods of low flow in the river by formation of sand bars. Also most outfalls on coasts under action of littoral drift show instability and migrate in the direction of the prevalling littoral drift while few outfalls move in the opposite direction (Wijesekera and Hettiarachchi 1983). In the Kalu ganga there is the regular formation of sand bars. Failure to control their build up is the major contributory factor in the accumulation of flood water in the Kalutara district. At the outfall of Kalu ganga there are two sand bars — the northern and southern sand bars shown in figure 9. The length of the northern and southern sand bars tend to have an inverse relationship when one increases the other decreases.

According to the maps available dating back to 1929, the river mouth has migrated northwards and southwards periodically. Although the river mouth migrates to the north and south there is no appreciable change in the width of the actual river mouth defined by the two sand bars (Madduma Bandara et. at 1987).

An important feature of the Kalu ganga estuary which has a significance in the movement of water is the presence of a lagoon located between the river and the outfall. The stability of the outfall is dependant to a great extent on the flushing ability of the estuary. For this in addition to the river discharge there should be sufficient tidal flow available to ensure the transportation of material away from the inlet.

Thus in the Kalu ganga outfall area there is sand bar formation, instability of the river outfall and the presence of the lagoon which aggravate the flood problem of the district.

At present the evacuation of flood waters during periods of heavy rain is done by local residents by breaching the northern sand bar to prevent flooding of the low lying areas. Wijesekera & Hettiarachchi (1983) report that the estuary shows a negative response towards an increased number of outlets which are created by the artificial opening of the sand bar. Both outfalls never remain open for more than a few weeks resulting in the closure of the former or the newly created opening.

To overcome the flood problem several measures have been taken. One is to attempt to stabilize the outfall. Outfall training works consisting of boulder groynes and rubble revertments were constructed in 1976 to stabilize the outfall in order to protect the tourist complex. The results obtained in attempting to stabilize the outfall have been satisfactory to a large extent. Shore protection groynes built were successful in trapping littoral deposits without causing adverse effects to the northern sand bar located on the opposite side of the outfall. As a result of the existing groynes local erosion may develop on the northern side of the groynes. Thus planning, design and construction of outfall stabilization structures which will not cause long term implications is no easy task.

Another way of tackling the problems of flooding is by having flood protection schemes. In Madurawela a scheme is planned for flood protection and on completion in 1992 would benefit 1300 acres since it would improve agricultural production and prevent flood damage to paddy land. This scheme has seven anicuts and would drain out water to the Kalu ganga. A Bentota ganga right bank scheme is in operation for the Bentota ganga for flood protection.

A major project — the Kalu ganga Multi Purpose project is planned for the Kalutara and the Ratnapura districts with the World Bank acting as the executing agency for the prefeasibility studies. The feasibility of this project is being studied at present, The principal features of this project that are being studied are the reduction flood damage to about 10,000 hectares of land in the Kalutara and Ratnapura districts thereby improving their agricultural productivity, the prevention of floods in urban and rural areas, the generation of hydropower at two possible sites namely Kukulegama and Ratnapura by constructing dams to impound the waters of Kalu ganga, the transbasin diversion of Kalu ganga waters to the south-eastern dry zone contributing to increase in agricultural production in these areas, the development of near shore and inland fisheries based on Kalu ganga.

Another problem faced in the Kalu ganga outfall region is the salt water intrusion during the low flow of the river. The dry weather flow of Kalu ganga at Putupawula is 30–40 cubic m/sec. At this flow salt water enters the river up to Narthupana. The salt water intrusion can have severe impacts when water is used for irrigated agriculture. This problem of salt water intrusion has been reported from the AGA division of Walallawita. too. The

problem here centers around the Bentota ganga and not the Kalu ganga. For the Bentota ganga there is at present the Bentota ganga right bank scheme in operation to prevent salt water intrusion and floods.

Recommendations for Protection/Mitigation

For the Kalutara district the minor flood protection and salt water exclusion schemes that are in operation at present should continue. The structures built for the operation of these schemes should be maintained well and not allowed to fall into disrepair.

The minor flood protection schemes whose prefeasibility studies has been completed should be implemented since the implementation of the Kalu ganga multi purpose project would take a long period of time. The multi purpose project for which the prefeasibility studies are in progress should draw in local expertise from various fields especially people who have experience with the Kalutara and Ratnapura districts to study the various options available. This project at present does not seem to have much emphasis on the Kalu ganga outfall region. It is hoped that the features of this region is taken into consideration. This project should solve the problems connected with flood damage for the Kalutara district and should be implemented after the feasibility and Environmental Impact Assessments have been made.

CHAPTER 7

COASTAL EROSION PROBLEM

Another major natural hazard faced by the district is that of coastal erosion. Even though this is a problem due to natural causes it is being aggravated by human interference.

The Kalutara district has 40 km. of coastline. The coasts of this district are predominantly sandy and are therefore dynamic (1986 Master Plan — Coast Erosion Management). This coast too like most coasts of Sri Lanka has been subject to erosion since time immemorial. The erosion/accretion figures given for the district in 1986 in the Master Plan — Coast Erosion Management are as follows:-

Erosion 70% to 80% of the coastline

Accretion 20% to 30% of the coastline

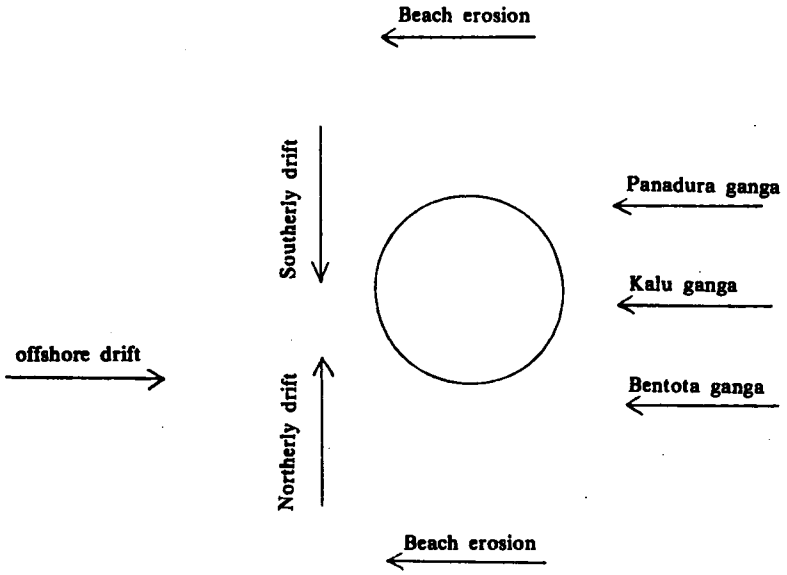
Average net erosion 0.4m/m/year to 0.5 m/m year

Net area loss estimate 10,000 m^3/year to 20,000 m^3/year

Range of specific erosion rates is as high as 0.1 m/year to 1.2 m/year

The nature of the sediment budget of an area determines whether the coast is erosional or depositional. Figure 10 shows the sediment sources for the Kalutara beach.

Figure 10
Sediment sources for the Kalutara beach (taken from Madduma Bandara et. al 1987)



The Kalu ganga, Panandura ganga and Bentota ganga all bring in beach sediment for this coast. The Kalu ganga is by far the most important sources of beach sediment for this area. It ranks first in terms of sediment

production and second in terms of sand production (Irrigation dept., 1974). Compared to the Kalu ganga, the Panadura ganga and Bentota ganga have much smaller basin areas and the sediment contribution from these rivers is also very much less (Irrigation dept., 1974). The sediment supply from the rivers vary considerably over the years and the highest runoff occurs in May and September–October periods.

The most critical period of the year for the southwest coast of Sri Lanka is the period of the southwest monsoon. The waves coming from the south–west reach the coastline at an oblique angle generating currents which flow in a northerly direction. These currents are responsible for intense erosion along the coastline.

Although the Kalu ganga and the south–western rivers wash much sand into the sea during the wetter months (April to November) most of this happens when the seas are rough, shore erosion is active and littoral drift is energetic. Therefore the bulk of the sand that is brought in by rivers is carried northwards, while some escape east of Dondra, only small amounts remain to be washed ashore during the southwest monsoon period. The direction of the longshore drift in the west coast from Kalutara is northerly. Recent estimates of the littoral transport rates along the coast of Kalutara indicated a northerly drift of 236,000 m^3/year and a southerly drift of 72,000 m^3/year resulting in a net northerly drift of 164,000 m^3/year in the neighbourhood of the Kalu ganga outfall.

The erosion in this coastline occurs therefore when the supply of sand-size materials to the shore is not adequate to fill the imbalance created by the littoral transport and thus it is not possible to maintain the sandy coasts of the area.

Until the coastal areas become centres of population concentration, erosion in the coastal area was mainly due to natural causes discussed earlier. At present a large number of poeple live in the coastal areas of the district and are engaged in coastal resource use in the form of fishing, sand mining, tourism, coir industry etc. Some of these activities are extremely harmful to the coastal environmental and accelerate erosion.

Sand mining has aggravated the problem of erosion. In the Kalutara district there is both the extraction of river sand and sea sand. According to a survey conducted by the People's Bank (1984), from the Kalu ganga 46,667 cubes of river sand are extracted per year, 294.5 cubes of sand removed per day from 67 landing sites. These activities in the river are more or less under licence but usually the actual volume extracted is higher than the permitted volume. The extraction of river sand not only aggravates the coastal erosion by reducing the supply of sand to the coast but it also causes the degradation of the river banks.

According to the available data, the extraction of sea sand between the landing centres of Thalpitiya and Panadura estuary was 49% of the total sea sand extraction. Thus the Kalutara district seems to contribute substantially towards supply of sea sand. According to the figures from the People's Bank Report (1984) in the Kalutara district there are 3 major landing centres indicated in table 6.

Table 6

Centres of sea sand extraction in the Kalutara district and quantity extracted.

Name of Landing	Number of Sites	Number of cubes removed per day	Number of cubes removed per year
Thalpitiya	6	14.5	2,988
Nalluruwa	15	14.5	3,756
Panadura estuary	2	4.5	1,080

The sea sand mining activity is based mostly on demand.

The reclamation of marshy areas in the lower flood plain have a positive effect because they no longer trap sediment during the floods. This would have the impact of increasing the supply of sediment to the sea.

Another cause for aggravation of the erosion hazard is the intense use of the coastal resource for tourism, human habitation and fishery development.

In the district there are 14 tourist hotels (10 hotels in Beruwela and 4 hotels in Kalutara) according to the accomodation guide 87/88 of the Tourist Board. Due to construction of hotels too near the water's edge, there is the vertical wall effect which leads to greater erosion by the waves. The disturbance caused to the beach and the vegetation in building these hotels also aggravate erosion in these areas.

Along the coast in the Kalutara district as in many other coastal areas, there are a large number of fishermen's huts. These huts are built on crown land and on the beaches themselves. The huts are more densely situated in Panadura and Kalutara coastal regions and in the rest of the coast they are more sparsely situated. The huts are more or less line spread out along the coast. In addition during the last 3–4 years people have come to occupy the sand spit behind the Kalutara railway station. It is observed that the community of fishermen in these huts have no toilet facilities and they pollute the beaches. They also dump waste on the beaches since there is no system of garbage collection by the local authorities extending to these areas. This has resulted in the pollution of the beaches and has often affected the health of the community adversely.

In the Master Plan — Coast Erosion Management (1986) prepared as part of a coastal zone management plan, erosion affected areas are categorised under two broad headings:–

(a) Key areas (b) Singular cases

Key areas have been defined as those of morphological complexities incorporating several characteristic morphological elements, whose diverse development pressures predictate the need for complex solutions and cover a coastal reach of several kilometers in length.

Singular cases have been defined as those which can be treated in isolation and cover a limited coastal area where the processes causing erosion are self evident or easily ascertained.

For the Kalutara district two key areas Kalutara and Beruwela/(Bentota) have been identified and are shown in figure 11. Figure 11 shows as if Kalutara district has 3 key areas. But the Moratuwa (Island) comes under the Colombo district. Thus for the Kalutara district there would be 2 key areas to be concerned with – areas with morphological complexity requiring complex solutions. These two key areas would be discussed in relation to the nature of problem, coast protection status and recommendations for solving the problem as given in Sri Lanka Master Plan Coast Erosion Management South West Coast Vol. 4 (1986).

Kalutara Key Area

The key issues in this area are:–

(1) to keep the Kalu ganga outlet open and to ensure the release of backwater

(2) to ensure tolerable navigational conditions for fishing vessels using the river outlet

(3) to minimise erosion problems on the coast related to instability of the outlet

(4) to ensure permanent stability of the southern part of the south barrier spit on which tourist development and settlement schemes have been located.

It is to be noted here that some of the key issues of this area would be the same as that for the flood hazard discussed in the previous chapter.

Coast protection measures have been taken to overcome problems in this area. A number of, groynes each about 15 to 20 metres and a boulder revetment have been constructed to overcome the erosion in the Kalutara north stretch. Due to the extreme threat of erosion and subsequent damage to housing and the coastline road, a sand nourishment scheme too has been initiated. A total of 10,000 m^2 of sand was used from the Kalu ganga river mouth to nourish the beaches to the north of the outlet. In 1981 emergency coast protection measures were taken to protect the Kalutara south railway station when it was threatened with direct wave attack due to the shifting of the river mouth. A field of five groynes has been constructed at Katukurunda to stabilize the southern tip of the Kalu ganga

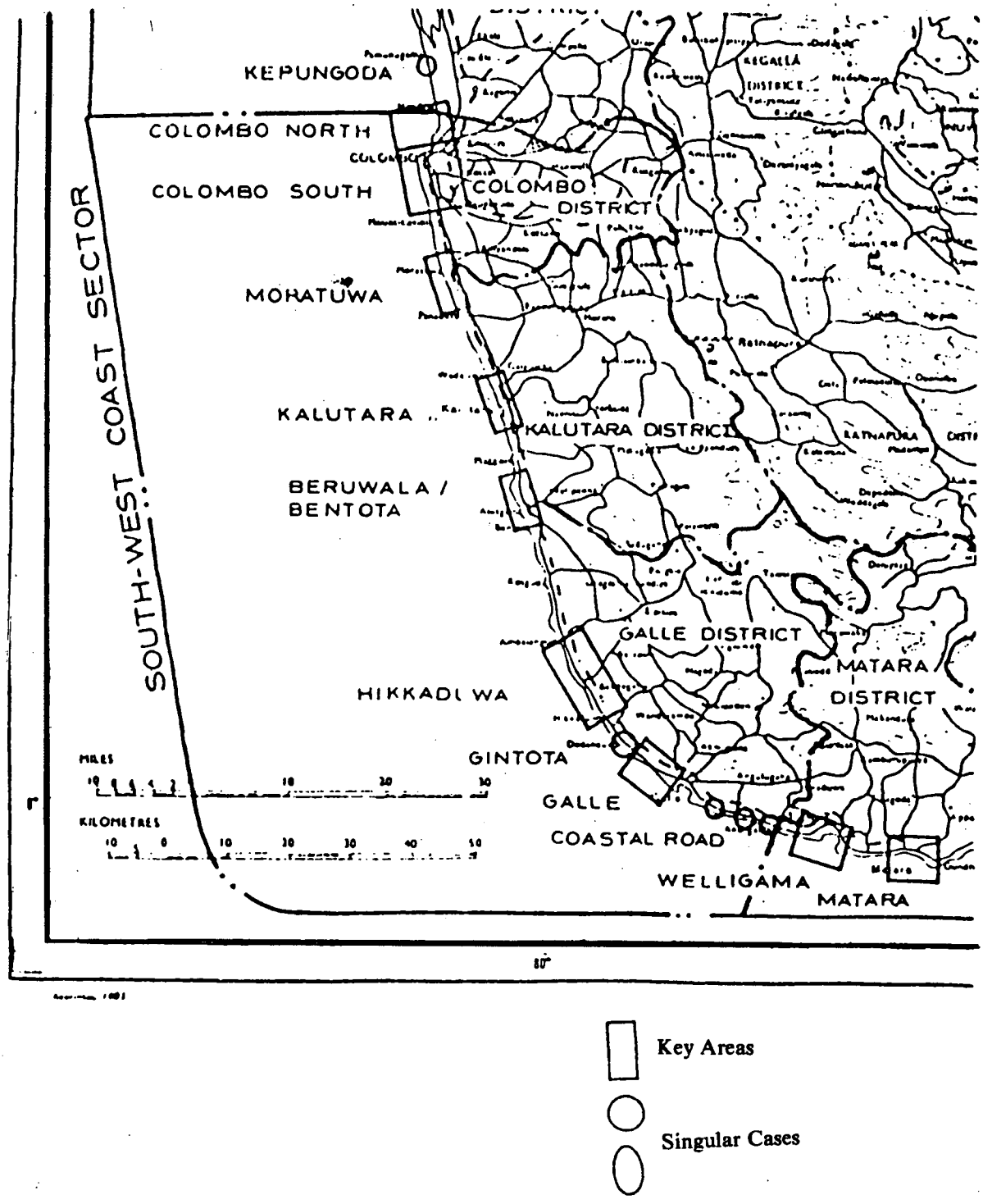


Figure 11– Key areas of the Kalutara district (from Master Plan Coast Erosion Management Vol. I 1986)

spit which was threatened by erosion where a tourist hotel is located. A revetment of 125 m was constructed to protect a fishing village at Katukurunda when erosion was reported.

It has been recommend that for this key area further groyne system be built and maintained north and south of the barrier system to stabilize the changing outlet conditions. The proposed protection measures are as follows:-

At Katukurunda beach hotel - extension of northern most and the third groyne, extension and rehabilitation of revement to mitigate migration of river.

Southern spit bar — execution of 1400 m sand dike to prevent overtopping and breaches of the bar.

Kalutara North — groyne extension combined with nourishment.

Tangarine beach — new groyne structure and nourishment.

Beruwela (Bentota) Key Area

In this key area due to the improper siting of the Beruwela fisheries harbour in 1964 a number of problems have been created. There is abnormal silting in the harbour and at present there is an yearly sedimentation of 20,000 m^3 of sediment. Just north of Colombo road from Magalkanda to Polkotuwa for a stretch about 1.5 km. South of the Beruwela headland fragile and unstable beaches are found. Generally in this key area beaches are without much problems due to the wise plannning of hotel location by enforced set back lines. However near the Lihiniya Surf Hotel on the southern end of the Bentota spit and the stretch between Kaluwamodera point and Palligalla there has been erosion during the recent years.

To prevent wash off of the main road protection work which involved the construction of groynes and revements, and earth back filling has been carried out on a planned basis. Here there are6 groynes associated with 1000 m revetment to protect the road. However due to lack of filter, these revetments have been undermined over the years causing damage and even undermining the road. Extensive back filling and maintenance work was carried out in 1981. Revertment have been constructed to protect the beaches south of the Beruwela headland. Due to inadequate filter, these revetments too have been undermined. Periodic erosion of the Bentota spit near the coastline adjacent to Lihiniya Surf Hotel has been protected by sand bags as an emergency measure and a groyne was constructed in the 1970's.

The proposed protection measures for the key area are indicated below. To construct a new eastern breakwater and to construct groyne or offshore breakwaters to check sediment transport towards the harbour. To implement a beach nourishment scheme to substitute the losses from the systems over the decades. The dredging programme for the harbour improvement could be co-ordinated with the beach nourishment scheme. It is however likely that the sediments now deposited within the harbour are of finer gradation than those required for the nourishment project. If so, other resources of more coarse grained materials will have to be located to supplement this scheme.

Recommendations for Mitigation/Protection

From the data presented it can be seen that for the major erosional areas of the district (key areas) the issues have been identified and in addition to the coast protection structures already present more structural construction has been planned to control coastal erosion.

However steps should be taken to reduce the aggravation of the problems by resource use by humans. The coast conservation set provides the necessary regulations to curb sand removal from the beaches. However the removal of river sand which is done on the issue of permits should be carefully checked. Efforts should be made to check whether the people take out the quantities specified in the permits from the locations specified. Additional permits should not be issued for removal of sand if possible.

Areas in Panadura, Wadduwa and Kalutara have been identified as suitable for fisherman's villages. The fishermen and their families presently located along the coast should be relocated in new cluster villages. The huts should be in clusters so that the basic facilities such as toilets. scavenging outlets and basic community facilities could be more easily provided. This would free the beaches for recreational use and would allow the seashore vegetation to come up again so that the beaches would be made stable.

The Coast Conservation Act also provides guidelines for location of tourist hotels. Thus even here what is important is that these regulations are adhered to strictly when permits are issued for hotel construction. This problem at present is remarkably less since there are no people interested in tourist hotels.

In Sri Lanka so far not much importance has been given to the stabilization of beaches by vegetation. The Coast Conservation Department some time back initiated some projects on the stabilization of beaches and sand dunes by planting various sea shore plants. If this methodology is available, under the guidance of the Coast Conservation Department students of environmental societies and hotelliers could be encouraged to try this out for the Kalutara district to protect some of their beaches.

CHAPTER 8

AIR POLLUTION PROBLEMS IN THE KALUTARA DISTRICT

Air pollution in the Kalutara district is caused by three main sources Associated Motorways, Metal Crushers and Lime Kilns.

Air Pollution caused by Associated Motorways Burning of rubber scrap

The problem caused by Associated Motorways situated in the AGA division of Kalutara has been brought to the notice of the District Environmental Agency since it has been creating some inconvenience to people living in the neighbourhood.

Assocaiated Motorways is a company involved in the manufacture of bicycle tyres and tubes, retreading of tyres, manufacture of rubber products for export and the assembly of Yuasa batteries. the energy for these various processes is supplied by the burning up of firewood and oil in boilers. Since this company manufactures rubber goods and also does retreading of tyres there is generated a substantial amount of rubber cuttings or scrap. This rubber scrap is sometimes burnt in a special boiler for the generation of energy. When rubber scrap is burnt, due to the incomplete combustion, particles of carbon are released to the atmosphere. These get carried away by wind and get deposited in various places. The complaints by people started when the clothes left on the lines to dry got covered with black particles. This complain may be against the initial stages of the air pollution problem caused by the burning of rubber scrap.

The management of Associated Motorways has reacted positively to the complaints made. So to overcome the problem an incinerator has been designed and fabricated by the National Engineering Research and Development Centre for Sri Lanka (NERD) and it has been installed in the factory premises in January 1988. In this incinerator rubber scrap and air are fed into the incinerator chamber and burning takes places with the conversion of the long chain hydrocarbons to short chain hydrocarbons, carbon monoxide, hydrogen and methane. These are then led into the boiler with a secondary air supply to cause complete combustion. Dust separators or scrubbers have not been incorporated to the incinerator at present. The by products left by burning of rubber scrap are ash and a substance similar to clay and high tensile wires of tyres. These can be removed from the incinerator through an opening and except the wires the rest is suitable for land filling.

Even though the incinerator was installed in January 1988, after being in operation for a few days it encountered problems due to accumulation of ash. The engineers of NERD who designed this are trying to modify the design slightly to enable regular ash removal while the incinerator is working.

At present however Associated Motorways is not using this boiler for burning rubber scrap due to the incinerator problem and is using fuel wood instead,

Recommendations for Protection/Mitigation

The incinerator should be installed as soon as the adjustments are done and the system should be studied to determine whether dust separators or scrubbers (if sulphur is present) are necessary.

Lead

Another possible air pollution problem could come up (or might be already there) in Associated Motorways. This is connected with the assembly of Yuasa batteries and the recovery of lead from lead plates of old car batteries. The management is of the view that in the assembly of batteries the only effluent that is released is dilute acid which is led into a pit. They are of the opinion that since the recovery of lead is done on a small scale no pollution will

occur. However the area in the premises where waste recycling is done has been slightly modified. the roof in this section has been raised and the height of the stack also has been increased.

During recent discussions held with the management it was understood that at present the battery assembly factory has ceased operations. The future plans according to the management are not known.

Lead in the atmosphere causes concern bacause of its accumulation effects. Lead poisoning can take place through inhalation and the most important toxic effects caused by lead are those on the brain and nervous system. Lead could result in permanent brain damage to babies and children. The mean annual average concentration of 2 ug/m^3 is the limit proposed by the European Economic Community. At present Sri Lanka does not specify a standard for lead in air emissions.

Recommendation

The lead concentration of air in the factory where batteries are assembled and lead is recovered should be determined and if it is higher than the specified levels of 2 ug/m^3 precautions should be taken to minimize the lead in air. The lead in blood and lead in urine of workers in this factory should be determind regularly and if these levels are high the workers should either be given a period of leave or be shifted to another processing unit of Associated Motorways. The management should be made aware of the problems that could result in lead based industries. Since the pollution effects with such pollutants go unnoticed, it is essential that the management be aware of the problems it can cause in their workers, and the workers too should be made to understand the risks involved in such work and the importance of regular health examinations. The division of Occupational Hygiene has done considerable work on lead poisoning in Sri Lanka and their help could be obtained in this case.

Air Pollution caused by Metal or Stone crushers.

The second cause of air pollution in the Kalutara district is that caused by "Metal crushers". There machines generally referred to as metal crushers are really employed to crush large blocks of gnessic rocks into various sizes to be used for building construction, road works etc.

When these blocks of stone are crushed there is a considerable amount of dust or rock power and noise generated. The composition of the rock powder as analysed by the Geological Survey Department in 1984 is given in table 7.

Table 7

Analysis of rock powder generated due to crushing of stone blocks.

Silica (Sio_4)	59.48
Alumina (Al_2O_3)	19.18
Iron oxide (Fe_2O_3)	7.94
Titanium dioxide (TiO_2)	0.76
Manganese oxide (MnO)	0.05
Phosphorus pentoxide (P_2O_5)	0.02
Calcium oxide (CaO)	1.68
Magnesium oxide (MgO)	2.66
Sodium oxide (Na_2O)	3.51
Potassium oxide (K_2O)	3.81
Combined water	0.80
	99.89

The rock dust can cause several problems. The rock dust gets carried by wind and causes air pollution. Damage to lung tissues and lung diseases can be caused by exposure to dust particles. The development of lung diseases depends on the amount of dust inhaled, the percentage of free silica in the dust, the size of particulates inhaled and the duration of exposure.

The rock dust can get deposited on leaf surfaces and this can interfere severely with the photosynthetic process and reduce productivity. Also the stone dust could get carried by rain water when it flows over the surface of the site

(where the metal crusher is located) and get deposited in the adjacent low lying areas or paddy fields. This deposition will not lead to toxic effects as can be seen according to the composition given in table 7. Thus the problem encountered will be a process of siltation by the deposition of dust. If the deposition occurs in paddy fields it could result in a decrease of yield over a period of time.

Another problem connected with metal crushers is the noise pollution.

Recommendations for Mitigation/Protection

It is recommended that a ventilation system consisting of a hood, ducting, dust separators, a stack and a fan be installed in each metal crusher to trap the dust and send the air out through the stack. To reduce the noise it is necessary to restrict the hours of work suitably to reduce the nuisance to the neighbours. Also the machinery should be properly mounted to minimise vibration effects. Tall trees should be planted at the boundary to act as barriers for both dust and noise.

Air Pollution due to Lime Kilns

The third source of air pollution for the Kalutara district is due to the burning of lime in lime kilns. This problem has been reported from the AGA division of Panadura where in one locality Pallimulla itself there are about 17 lime kilns. The problem of lime kilns is not restricted to the AGA division of Panadura but is seen in almost all the AGA divisions of Kalutara.

Here the main problem is that of smoke generated during the burning of lime and dust generated during crushing etc.

Recommendations

Here too as for the metal crushers a system having a hood, ducting, dust separators, a stack and a far should be installed to reduce the dust generated and the smoke.

CHAPTER 9

PROBLEMS CAUSED BY DISTILLERY EFFLUENTS

Kalutara district has environmental problems caused by wastewaters containing biodegradable organic material. These could be discussed in one chapter since the methods of pollution, the basic treatment methods etc. are similar. But in this report they would be discussed since the particular industry generating the wastewater since the work already done in Sri Lanka and the preliminary work carried out at the laboratories of the Department of Botany, University of Colombo will be different for the different type of wastewater.

One important industry in the Kalutara district generating effluents containing biodegradable organic wastes is the production of arrack by distilling coconut toddy. According to the figures made available by the State Distilleries Corporation for 1987, Kalutara district processes about 26,000,000 pure litres of toddy while the Puttlam district processes about 6,000,000 pure litres of toddy. Out of the toddy from Puttalam part of it is distilled at Seeduwa in the Gampaha district. Thus the Kalutara district distills about four times more toddy than the other districts handling toddy. Thus in terms of pollution too the problem of distillery effluent is greatest for Kalutara out of the districts of Sri Lanka. In the Kalutara district however since there is no toddy tapping during December to March no distillation is carried out during this period.

In the Kalutara district there are six distilleries namely Beruwela distillery Beruwela, Kalutara co-operative distilleries Society Ltd., Malegoda, Mendis distillery Moragalle, Rockland distillery Magalkande, Sri Lanka distilleries Ltd., Wadduwa and Wawulugala distillery Maggona. Toddy from the neighbouring areas are brought to these distilleries for the production of arrack. In some distilleries like Beruwela distillery, Kalutara co-operative distillery and Wawulugala distillery, their main task is the distillation for alcohol. But distilleries like Rockland, Sri Lanka distilleries and Mendis distillery produce alcohol but their major task is the blending of these to produce different types of alcoholic drinks.

The principle waste from these distilleries is the spent wash generally referred to as "goda" which is the wastewater discharged from the alcohol stills after distillation of toddy. Other wastewaters originate from the washing of fermentation vats, floor washings and cooling and condenser water as reported in Industrial Pollution control Guidelines (1982). In some distilleries the cooling and condenser water is not released but reused after cooling. There is particularly no solid waste produced in a distillery. The yeast sludge which deposits in fermenters is recovered by many distilleries and is used in animal feed. However in the distilleries of Sri Lanka the sludge is drained along with the spent wash which then adds to the pollution load. The spent wash from a distillery has a very high temperature and Biochemical Oxygen Demand (BOD) and is acidic.

The pollution effects of waste water of these distillation industries on a water course are therefore multiple in nature. High temperature of the wastewaters may instantaneously kill fish and other aquatic organisms when the wastewaters are discharged into it. The acidic nature of the wastewaters can destroy the normal aquatic organisms and inhibit the self purification of streams.

Suspended solids present in the wastewaters after entering a water course can settle at the bottom and destroy fish breading areas.

The most damaging effect in the wastewaters of a distillery on a stream is caused by high concentration of readily decomposable organic matter present in the wastewater. These when added to water, cause the activity and the reproduction of the micro-organisms to increase resulting in the consumption of oxygen dissolved in the water. Thus high BOD of the wastewaters cause rapid depletion of the oxygen content of the water, creates foul smells

because of the anaerobic conditons, promotes growth of nuisance organisms and renders the stream totally unfit for propagating fish life and for drinking and other purposes.

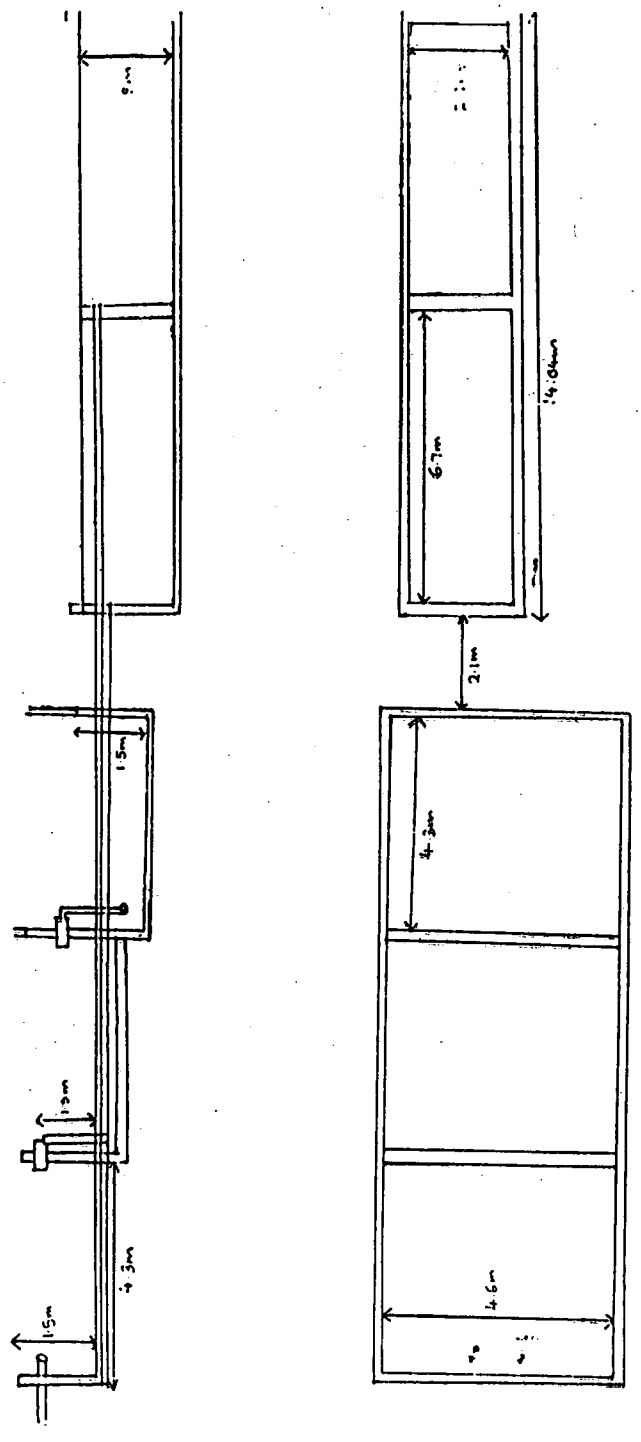


Figure12- System of tanks for distillery effluent at Wawulugala distillery

Air pollution can also be caused by emission of particulates from boiler stacks. This can have adverse effects on human health and plant life. These particulates can damage vegetation by covering the surface of leaves, soil clothes, building and other structures and pose a health hazard when inhaled into lungs with air. This hazard of air pollution is not seen at present in the distilleries of the district. However as the wastewaters from distilleries have readily decomposable organic matter, stagnation of the wastewaters in the drains or in pools or ponds gives rise to obnoxious smells in its neighbourhood due to the anaerobic decomposition of the organic matter (Industrial Pollution Control Guideline 1982). This obnoxious smell is the environmental problem that has been reported around the distilleries of the district.

Thus for the Kalutara district this is one of the environmental problems that has to be solved with the installaion of treatment facilities.

In Sri Lanka till 1982 no standards had been laid down regarding the discharge of waste material into water courses. Even though standards are specified now by the CEA, most industries still discharge their waste without any treatment.

Distillery waste in the Kalutara district is somewhat different in the sense that since there has been public complaints to the District Environmental Agency about obnoxious smells, certain minimum precautions have been taken regarding the discharge of waste.

In the Wawulugala distillery the effluent from the distillery gets collected immediately outside the distillery in a tank and from here it is conveyed to a system of tanks built in series away from the distillery in land under rubber. This land is bordered on one side by paddy fields. The system of tanks is shown in figure 12. The first 3 tanks (each 4.6X4.3X1.5 m) are lined with concreate but the last two (each 6.7X2.1X1.8 m) are not lined. The goda merely flows from one tank to the other with some amount of yeast cells settling in the first and second tanks. There is seepage of goda from the unlined tanks and the ground cover of grass and the rubber trees in the immediate vicinity are dying due to this.

In the co-operative distillery Malegoda, the waste water from the distillery flows into three cemented tanks built in series (6.4X4.2X1.5 m each) shown in figure 13. Earlier the wastewater from here was directed to a large pit from which it entered a stream nearly. After the CISIR reported on the wastewater from the distillery in 1987, the wastewater from the series of three tanks is being led by a pipe into two tanks (4.2X3.6X2.9 m each) which contain stones up to a depth of 1.4 m. The wastewater falls on to these stones through a perforated pipe-most probably this has been installed as a trickling filter system. The goda from here seeps through the soil (the original large pit is in the process of being filled up) into what is remaining of this large pit and then joins the stream.

In the Beruwela distillery the wastewater flows into 3 cemented tanks built in series.

In the Sri Lanka Distilleries Ltd., Wadduwa the goda flows into a large unlined pond (about 12X15 m in size located away from the distillery on marshy land with a stream on one side. This pond does not overflow unless there are heavy rains.

In the Rockland distillery discharge is directly to the water courses in a paddy field and there are no tanks or ponds for retention of the effluent. The waste is carried by pipes to underground tanks (not storage tanks) and then released.

In the Moragalle distillery site examination was not possible since permission could not be obtained even from the Head Office at Colombo. However the information received from the management revealed that here the goda went into an underground tank sealed with a slab and from this there was a perforated pipe leading the goda into soil.

Out of the treatments available a systematic attempt has been made only by the co-operative distillery, Malegoda and Wawulugala, even though these too are not functioning as they should do. In Beruwela the tanks constructed are totally insufficient and it appears that most of the goda can be directed through a channel directlyto

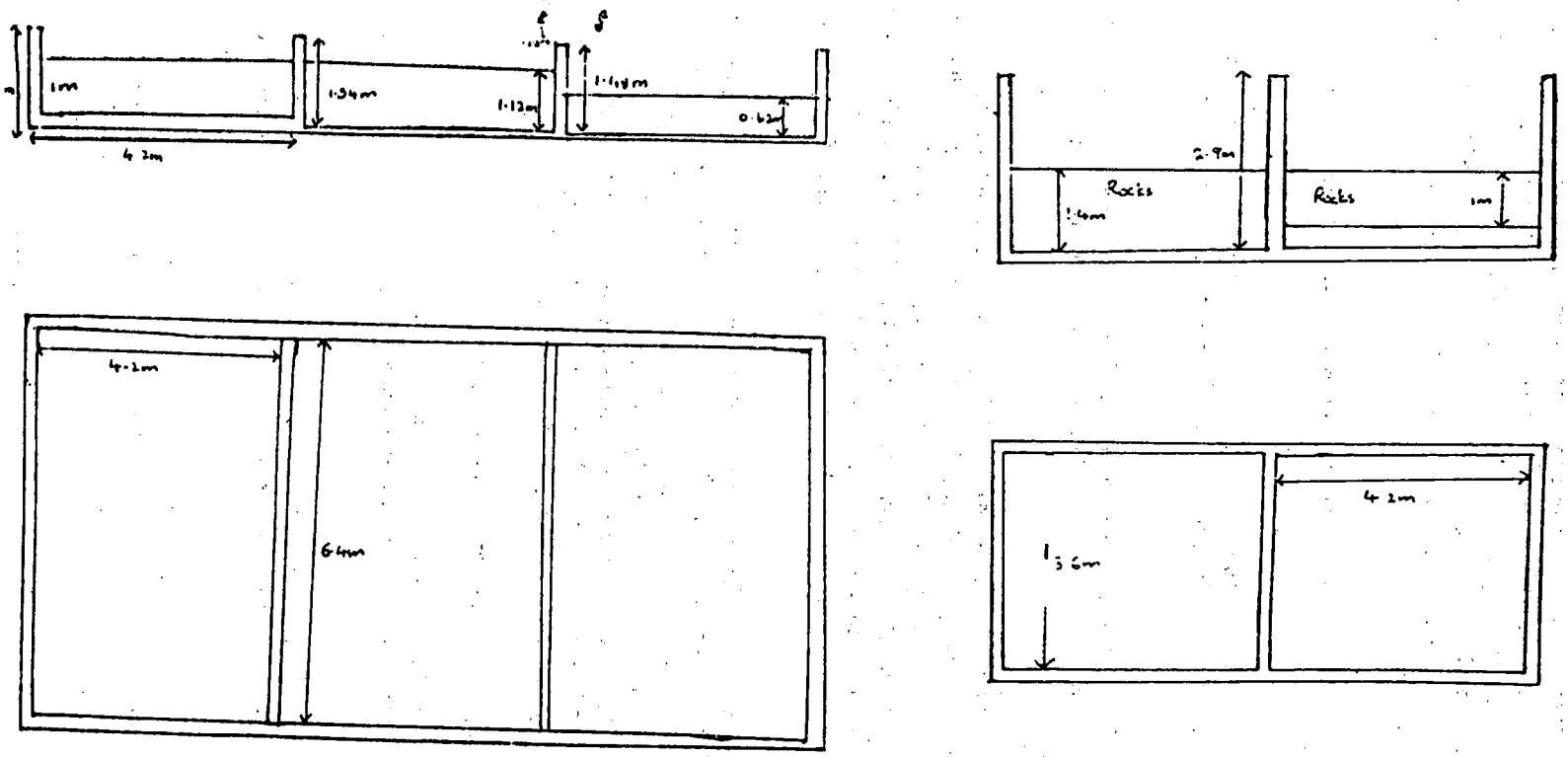


Figure 13 – System of tanks for distillery effluent at Co-operative distillery, Malegoda.

the water course without going through the tanks. The Beruwela distillery is situated ideally so that even without much treatment it does not appear to cause much pollution since it discharges to the Kaluamodara ganga which flows without stagnation.

In all cases even though some type of tanks are built there is no treatment being done and the effluent either moves into the environment slowly through the soil or moves directly into the water course.

Several methods are available for the treatment of spent wash of an alcohol distillery. Industrial Pollution Control Guidelines (1982) gives three methods by which spent wash can be treated.

1. Evaporation and incineration of the waste to generate steam and recover potash-rich ash.
2. Anaerobic digestion in closed digesters to recover fuel gas (methane) follwed by aerobic biological treatment.
3. Anaerobic lagooning followed by aerobic biological treatment in aerated lagoon or oxidation ditch.

The aerobic purification of wastewater is based on the decomposition processes of organic materials caused by various bacteria in the presence of oxygen. In addition to the bacteria other organisms also take part in the decomposition. During the process, a considerable amount of organic matter present in the wastewater is oxidised by means of cell respiration to carbon dioxide and water. The important environmental requirements for micro organisms when dealing with aerobic purification of wastewater are the presence of sufficient dissolved atmospheric oxygen, sufficient nutrient content (nitrogen and phosphorous), a suitable temperature, a suitable pH value and a sufficiently low concentration of poisonous materials. The temperature should be generally under 50° C. Oxidation of organic materials occur most rapidly within the range of pH values 6–9, the optimum value apparently being pH 7.3. For optimum biological growth many elements have to be present in the effluent, but only carbon, nitrogen and phosphorus need to be present in any quantity. As the purpose of biological treatment is generally to utilize the soluble organic carbon only the elements nitrogen and orthophosphate as these forms of N and P are readily available for assimilation by the microflora. Distillery effluents are usually deficient in both N and P and these are added to produce an influent ratio of BOD:N:P of 100:5:1 (Ripely 1979). The possible aerobic methods that could be used are aerobic lagooning and activated sludge treatment.

In the anaerobic treatment, methane (a useful energy source for many practical applications) and carbon dioxide are produced as a result of the decomposition of complex organic compounds such as carbohydrates, proteins and lipids. For anaerobic fermentation two temperature ranges are regarded as optional for the culture of bacteria, the mesophilic (5–45° C) and the thermophilic (50–70° C). 44° C is regarded as the optimum within the mesophilic range and in practice the best temperature range has proved to be 30° –40° C. Although the bacteria act more rapidly within the thermophilic range, it is not normally used in practice as the process has high thermal losses and requires careful control. It is important that the temperature remains as stable as possible and sudden temperature variations of more than 5° C should therefore be avoided. pH is of great importance in the anaerobic decomposition of wastewater. A neutral value (7.0–7.2) is regarded as the optimum pH for methane fermentation.

The development of anaerobic techniques has been rapid during the recent years. The long term technical development has produced various different processes and digesters. In India and China a widely used anaerobic method is the anaerobic stabilization pond.

Of the methods mentioned the anaerobic and the aerated lagoons are the low cost methods. But these require a large area of land owing to the slow rate of stabilization of the organic matter in the wastewater. In India to obtain between 80–90% BOD removal from spent wash of an alcohol distillery, a residence time of 70–120 days in the lagoons would be required. The BOD of the effluent from lagoons varied between 3000–4000 mg/ 1. Some of the problems observed in the lagooning of spent wash of alcohol distilleries in India were contamination of ground water due to seepage of the water from lagoon, smell nuisance in the vicinity, incomplete treatment of spent wash and high cost and restricted availability of land.

Anaerobic digestion of spent wash in a closed digester is a quicker process for removing the bulk of its BOD. It requires much less space than anaerobic lagoon and the problems of ground water contamination and smell

nuisance is absent. An additional advantage is that methane is obtained as a by product which could be utilized in the boiler for raising steam. Pilot plant studies carried out in India reported in Industrial Pollution Guidelines 1982 had an anaerobic digestion of spent wash in a closed and temperature controlled digester followed by its treatment on an activated sludge process. This had a removal of BOD greater than 99%. The spent wash has an average BOD of 50,000 mg/l and a temperature of 37°-38° C. As reported in the Industrial Pollution Control Guidelines (1982), a full scale biological treatment plant has been installed recently at a distillery in Phuket, Thailand to handle about 60m³/day. This treatment plant has thermophilic anaerobic digestion with sludge recirculation followed by activated sludge process. The capital cost of the waste treatment plant in Thailand is about $ US 250,000 and the operation and maintenance cost is of the order of $ US 40,000 per annum.

In certain countries there is the recovery of residues from the spent wash. In developed countries the recovery of yeast has been the practise for many years. The yeast is concentrated by centrifuging or filtering and then is either drum or spray dried. Recovery of potash by incineration of spent wash was at one time practised in the western countries, but it is no longer economical in view of the much cheaper price of potash obtained from natural deposits in many countires of the world. However some of the countries of South East Asia, especially India, Bangladesh and others, have no natural deposit of potash. Hence the scope of recovery of potash from spent wash of the distilleries located in these regions may be promising.

Since it was felt that the treatment facilities in existance at present is totally insufficient for the distillery effluent and since some information was avialable on the possible treatment methods and recovery materials, it was decided to carry out some preliminary studies on the distillery effluent. The main objectives of this study would be:-

(a) to determine the characteristics and quantities of effluent from different distilleries

(b) to compare the values with the standards specified by the CEA

(c) to try out treatment methods on a laboratory scale to improve the effluents to the CEA standards

(d) to recover yeast

(e) to determine possibility of using the effluent as a fertilizer

This part of the study was carried out keeping in mind the cost factor. Sometimes even though the optimum condition in temperature was 30° C attempts were not made to carry out the experiment at 30° C but it was carried out at room temperature (28° C) taking into consideration the additional cost and equipment necessary.

The quantity of goda produced and the characteristics of the effluents tested were pH, suspended solids, turbidity and BOD in 5 days at 20° C. The BOD was determined according to method given in American Public Health Association (1965). These are presented in table 8 for some effluents for which the tests were done.

Table 8

Quantity of effluent produced by different distilleries in the Kalutara district and some characteristics of the effluent.

Distillery	Volume of goda produced per day in gal. Maximum	Minimum	Suspended solids mg/l	Turbidity in NTU	pH	BOD in mg/l
Wawulugala	7500	3000		390-490	3.2-3.5	10,400-11,250
Malegoda	7000	3000	820		3.2-3.5	10,000-11,500
Sri Lanka Distillery	6000	-	1040		3.2-3.5	9,900
Beruwela	6600	-		200-300	3.2-3.5	2,288
Rockland	3800	1500			3.2-3.5	
Mendis		1300				

From table 8 it can be seen that the values for suspended solids and BOD are very much higher than those specified in the CEA standards for industrial effluents discharged into inland surface waters. The values specified in the CEA standards being BOD in 5 days at 20° C 30 and suspended solids 50 mg/ 1 particle size below 850. The pH of the effluent too is acidic and very different from that of the standards which specify a pH between 6 and 8.5. The quantity and quality of effluents released too is different for different distilleries in the district. Wawulugala distillery and the Co-operative distillery Kalutara producing more goda during the peak periods than the other distilleries. The BOD values for Wawulugala and Co-operative distillery, Malegoda are much higher than that of Beruwela. This is because in the Beruwela distillery the condenser water too is released with the spent wash after distilling. So, for the Beruwela distillery the treatment process could be shorter than that for the Wawulugala and co-operative distillery. The BOD values for the Co-operative distillery given in the CISIR report (1987) agree with the values obtained by us, but the value for total suspended solids is much lower than the value obtained. Thus from these results it can be seen that the spent wash has to be treated and brought to the required standards before release to the water courses.

Thus preliminary laboratory tests were carried out with effluents to examine the possibility of improving the quality. The effluent selected was that from the Wawulugala distillery. Effluent from this distillery was selected as this had BOD values similar to that of the Co-operative Distillery and were of the higher range of BOD that had to be reduced. Also the management was always very helpful and obliging that collection of effluent was no problem.

Experiment 1 To treat effluent under aerobic and anaerobic conditions at neutral pH. — October 1987.

Three glass tanks were taken and into each added 10 litress of effluent. Adjusted the pH of the effluent in all three tanks to 7.0 with potassium hydroxide since aerobic and anaerobic digestion works best at neutral pH. To one tank added 10 gm. of freshly collected cow dung to introduce the anaerobic organisms. The other tank was aerated using a pump and the third was kept as a control. The anaerobic set up was covered with a glass sheet to provide anaerobic conditions. On testing the pH the next day it was found that the pH had dropped to 4.0. Hence it was decided to use potassium carbonate to neutralize the effluent. Thus the experiment was set up again using K_2CO_3 to neutralize the effluent. At the end of two weeks it was found that the effluent was not clearing up in any of the three tanks and there were bad smells emitted.

This could have been due to various reasons. It might be that the effluent was too concentrated for anaerobic/aerobic processes to work or it might have been that in the aerobic set up no suitable organisms were available for digestion since no organisms were introduced from outside or that in the anaerobic set up the organisms introduced were not suitable for the treatment. Taking some of these considerations into account experiment 2 was set up in December 1987 to determine the dilution that had to be done for effective aerobic/anaerobic digestion.

Experiment 2 — To deterimne the dilution at which aerobic/anaerobic digestion will occur.

The dilution were worked out assuming the BOD of the effluent to be around 10,000 mg/ 1. The effluent was diluted to obtain BOD values of 6000 mg/ 1. 3000 mg/ 1 and 1000 mg/ 1 and the pH was adjusted to 7.0 using potassium carbonate. This experiment was carried out in tanks which had an outlet at the upper 5 litre level. In this experiment too two treatments were organised – aerobic as a control. Unlike in experiment 1, the organisms necessary for digestion were collected from the Sewage Treatment Plant at Kalubowila. Both activated sludge and the anaerobic sludge were brought from Kalubowila just before use in the experiment. In this experiment plastic string hopper "watti" (5 in each tank) were suspended in the aerobic and anaerobic tanks to provide the organisms a substrate to grow. For the aerated set up injection needles were inserted into a plastic tube leading from the pump to enable a better distribution of air within the effluent in the aerobic system. After two weeks it was seen that the least concentrated effluent (BOD value 1000 mg/ 1) was clearing up more rapidly than the rest. Therefore it was decided that further work should be carried out with effluents diluted to a BOD of about 1000 mg/ 1. Thus this would be a suitable value for initation of a treatment process.

The experiment was started again with effluent of BOD 1000 mg/ 1. Since there was some clearing up in the aerobic and anaerobic tanks at the end of 2 weeks, effluents amounting to 1 litre per day of (BOD about 1000 mg/ 1)

were added. The amount that overflowed from the tanks were collected for an experiment with aquatic plants. The BOD values are presented in table 9.

Table 9

BOD values in mg/l of effluent treated aerobically and anaerobically.

	on day 1	*after 2 weeks*	*after 1 month*
BOD of control	844	683	630
BOD of aerated tank	844	56	20
BOD of anaerolic tank	844	263	171

From table 9 it can be seen that the BOD at the start of the experiment was 844 mg/1. Thus even though the effluent was diluted to around 1000 mg/1 BOD, on testing the value was 844 mg/1. In this experiment after 2 weeks there is considerable improvement in the effluent quality in the aerated tank — the BOD coming down from 844 to 56 mg/1. In the anaerobic tank too the BOD has been reduced but to a lesser extent than in the aerobic tank. After one month this difference shows up clearly indicating that aerobic processes are more efficient for reduction of BOD levels than anaerobic processes.

There is at present extensive literature available on the use aquatic plants for wastewater treatment (National Academy of Sciences 1976). Hence experiments were initiated to determine the suitability of aquatic weeds for treatment of distillery waste.

The first experiment was designed to determine the plants which could be used for wastewater treatment. For this experiment the effluent overflowing from the anaerobic tanks (during the addition of fresh effluent) in Experiment 2 was used. Since the, effluent overflowing per day was insufficient to start the entire experiment, different plants were used with the overflow of a particular day. Thus the initial BOD value was determined and the plants were introduced. The plants were allowed to grow for 8 days. The results are presented in table 10.

Table 10

Plant species tested out for wastewater treatment

Date	*Plant species used*	*Initial BOD in mg/l*	*BOD value after 8 days in mg/l*
5.2.88	Control without plants	216	99
6.2.88	*Azolla*	279	144
8.2.88	*Salvinia*	189	41
9.2.88	*Eichhornia*	234	18
10.2.88	*Lemna*	225	81
11.2.88	*Pistia*	180	77
12.2.88	*Limnocharis*	171	16
13.2.88	*Ceratophyllum*	189	14
14.2.88	Control without plants	117	86

From this table it could be seen that *Salvinia, Eichhornia, Limnocharis* and *Ceratophyllum* are very effective in wastewater treatment. However *Limnocharis* is a submerged rooted in the mud, while *Ceratophyllum* is a submerged water plant. Therefore for large scale distillery waste treatment *Limnocharis* could not be provided a substratum for rooting and *Ceratophyllum* would be difficult to harvest after some time and also it would be difficult to see whether this would have problems of growth in the wastewater like for emergent plants. Hence *Salvinia* and *Eichhornia* were selected for furher experimentation.

Experiment two was designed to determine the maximum BOD levels the plants could tolerate. This experiment could provide some information whether anaerobic/aerobic digestion could be stopped earlier and the

final polishing could be started with aquatic plants. Thus effluents of 4 BOD values were worked with. The values used were 150, 200, 400 and 600 mg/litre BOD. *Salvinia* and *Eichhornia* plants were added to the effluents with the above BOD values and allowed to grow for a week. After a week the plants were examined. The effluents with BOD values of 400 and 600 mg/1 were toxic to the plants. But the plants could grow and reproduce in the effluents with BOD values of 150 and 200 mg/1.

Another experiment was carried out to determine the value of BOD at which most reduction is achieved. The plants of *Salvinia* and *Eichhornia* were added to effluents of BOD values assumed to be 100, 150, 200 and 250 mg/ltre. The true BOD values of these and also the BOD values after allowing the plants to grow for 4 days were determined. The results of this experiment are presented in table 11.

Table 11
Reduction of BOD by *Eichhorinia* and *Salvinia*

Initial BOD values		*BOD values after 4 days*		
Assumed BOD value in mg/l	*True BOD value mg/l*	*Control*	*Eichhornia*	*Salvinia*
100	117	65	32	27
150	167	110	32	23
200	230	216	54	59
250	254	216	189	158

From this table it can be seen that *Salvinia* and *Eichhornia* are very effective at the final polishing up of wastewater. Both *Salvinia* and *Eichhorinia* seen to be most efficient at a BOD value around 160 mg/1.

Another important aspect that was made very obvious during these experiments was that when the effluent improved mosquitoes started breeding in the wastewater. Thus this would be another problem that would have to be looked into. Initial experimentation with larvivorous fish was started but was not continued due to lack of time. Along with the polishing of the effluent it might be necessary to find out whether fish could be bred in these waters.

Recovery of Yeast

Nathanael (1953) on the basis of certain preliminary laboratory studies has found that on an average a recovery of approximately one pound of dried yeast could be made from every 200 gallons of fermented toddy used for arrack production. It is however anticipated that under conditions of commercial production the yields would be very variable. In Sri Lanka the practice is for toddy yeasts to be released with the effluents. If they are recovered and dried they could very well be regarded as a protein concentrate, most valuable as food for farm stock especially when mixed with other feed such as grain or oil cake. In certain countries like West Indies, the manufacture of dried yeast, compressed yeast and yeast food comprise a considerable industry.

The available method for separation of yeast cells is centrifugation. This method was found suitable for goda too on a laboratory scale. It was felt that this would be too costly for the distilleries. No success was obtained using filter paper, sand columns etc. for filteration. Hence it was felt that the possibility of settling the yeast with chemicals should be looked into. When the suspended solids failed to settle down, a jar test was carried out at the National Water Supply and Drainage Board laboratories using various coagulants like Aluminium hydroxide, Ferric chloride etc. This too did not give any promising results.

Possibility of using effluent as a fertilizer

Nathanael (1953) states that the mineral consituents of the waste imparts to it some manurial value. He adds that 1000 gallons of spent wash would contain 5.3 nitrogen, 17.1 potash (as K_2O) and 2.1 phosphorus (as P_2O_5). Nathanael states that a practical proposition for the economic utilization of the wastewater would be its direct application to coconut palms after treating with lime to reduce the acidity. Nathanael states that if the liquor could be applied to palms at the rate of approximately 60 gallons per palm per year, this would cover all the nitrogen

requirements of the palm, beside providing almost a luxury dose of potash and the palm would have to be supplemented only with phosphates.

Observations made at the Wawulugala distillery show that the wastewater seeping into the soil causes the rubber trees and the grass in the vicinity to die. In the other distilleries there are water courses nearby and the effects on the vegetation are not seen like at Wawulugala. Also in the Rockland distillery where the effluent joins a water course running through paddy fields damage is not observed in paddy. The management of this distillery also state that before the paddy fields are made ready for sowing some farmers divert the goda into their fields which they feel helps in a quicker decomposition of the paddy stubble.

Thus it was decided to carry out a greenhouse experiment to determine the effect of a goda on the growth of paddy. It was found that goda in its undiluted form was toxic to paddy and that paddy could be grown only in goda diluted sixteen times. At this concentration of goda the paddy merely survived without tillering or flowering. More work is in progress on the effects of goda on the growth of paddy.

These preliminary experiments revealed that the spent wash if it is to be used for the growth of paddy should be quite dilute and also fertilizer supplementation would have to be made to obtain the normal tillering or flowering.

Recommendations for Mitigation/Protection

According to the methods available in the Phillipines and India the best method of treatment would be in anaerobic digestion of the spent wash in a closed digester followed by the activated sludge method. These are however very costly both in terms of capital costs and operation and maintenance costs (with some amount of methane generated as compensation). These methods though the best for Sri Lanka in terms of low land requirement and non-pollution by seepage seem too prohibitive in cost for immediate implementation. However foreign assistance in terms of funds should be sought to cover about 75% of the cost even though some of these distilleries are private companies. The input of 25% by the distilleries towards the installation of a treatment plant is not unfair as everyone is aware of the profit margin of arrack distilling!

If some funds could be obtained, the CEA could lay down a 10 year dead line (from the time the funds are obtained) by which distilleries should have a suitable treatment plant installed. The CEA should at least try to persuade the State Distilleries Corporation which is at present leading its effluents directly into waterways to install one such treatment plant possibly at Seeduwa at least within 5 years. Discussions held with some of the officers here revealed that they have already visited such treatment plants in India. After such a treatment plant is installed the other distilleries would get to know what the plant looks like!

Till these possibilities are looked at some type of treatment of the effluent should be initiated. The anaerobic lagooning followed by aerobic lagooning with plants as a final polishing would be the best for treatment of wastewater. In all distilleries examined land could be made available for lagooning purposes. The work carried out at the Department of Botany could be utilized here. For some of the distillery waste eg. Wawulugala distillery and co-operative distillery, Malegoda a significant amount of dilution will be necessary before being made suitable for treatment. It should be made very clear to the management of the distilleries that this is a interim measure till the treatment system is installed. However efforts should be made to determine the efficiency of the interim method employed. If this method shows promise may be this could be improved and allowed to continue.

Another very important feature is that what ever system is installed or suggested the management should be made aware of the working of the various processes. It is only then that systems can be maintained well for proper functioning. This is evidenced in the Co-operative distillery, Malegoda where they do not know what the system is supposed to do. So a mere installation of a system is not sufficient — the management should be educated before they are advised to invest money!

CHAPTER 10

RUBBER EFFLUENT AS A POLLUTANT

Kalutara is one of the three main rubber growing districts of Sri Lanka. According to the Sri Lanka Census of Agriculture 1982 General Report, the acreage under rubber for the 3 districts are as follows:-

Kalutara 117,700 acres or 27.8%
Kegalle 113,464 acres or 26.9%
Ratnapura 72,471 acres or 17.2%

Kalutara district has 458 estates reporting rubber. Some of these estates are involved in the manufacture of sheet rubber while others produce crepe rubber. In addition there are rubber based industries in various parts of the district. All these produce rubber effluents which cause environmental problems. Thus for Kalutara a major environmental problem would be caused by effluents from the rubber industry — a pollutant containing biodegradable organic wastes.

Rubber latex contains about 30-40% rubber, the balance being called rubber serum. The main effluent coming from rubber producing factories is the rubber serum diluted with water. The characteristic of rubber serum are given by Yapa and Walpita (1983) and some are presented here. Rubber serum has a distinct acid reaction. This is caused by the acid used for coagulation (mainly formic) as well as by the acids formed spontaneously in the latex. Rubber serum contains proteins, amino acids, carbohydrates (mainly polyhydric alcohols, myoinositol and quebrachitol) a number of inorganic cations and the composition given by Yapa (1984) in mg/l is as follows:-

Nitrogen 625, Phosphorus 646, Potassium 745, Calcium 83, Sodium 366. The nature of the effluent depends very largely on the product to be manufactured namely RSS, brown crepe, pale crepe, TSR or latex concentrate. Of these the effluents from the latex concentrate production contain the highest concentration of the undesirable non-rubber constituents. In the manufacture of 500 Kg. crepe rubber, about 750 litres of serum and about 17500 litres of wash water containing serum are generated. However there are possibilities of reducing the volume of wash water to about 2500 litres for the manufacture of 500 Kg. crepe rubber.

In Sri Lanka the common practice for rubber serum effluent disposal is to discharge it through a suitable ditch into the nearest water course. This method has gone on for a long period of time and was thought to be satisfactory as long as it did not produce any offensive odours, even though it contaminates the water and its use for domestic purposes becomes questionable. Greater problems arise when factories cannot discharge their effluents into streams. These factories let the effluents flow into drains, paddy fields, part of plantations etc. During this disposal the proteins of the serum and small amounts of rubber are coagulated and contaminate the drains clog the soil and cause a bad smell. The problem of bad smells become serious if the factory is situated near a town or a residential area. Also the acidic effluent is found to cause damage to crops such as paddy and coconut palms.

Water pollution is caused by acid effluents in a similar way to that caused by goda given in chapter 9. When the dissolved oxygen in the water has been used up by the aerobic microorganisms for breaking down the organic substances present, the anaerobic bacteria begin action and cause bad odours due to the production of hydrogen sulphide and also cause a dirty appearence of the streams.

In addition to pollution of natural waterways by rubber factory effluents, it also causes odour pollution of air. High concentration of H_2S (2000 ppm) can be fatal. Prolonged inhalation of this gas (even at 10 ppm) can also be fatal. Mercaptans which are used in the crepe rubber manufacture for bleaching of latex to improve the colour of the final product, possess a strong unpleasant smell which pollutes the entire factory area for long periods. Yapa

(1984) reports that in some estates factory labourers exposed to such polluted air for long periods during their work have complained of chest pains.

As discussed in chapter 9 for distillery waste, similar methods since here too organic substances have to be broken down before disposal. So far rubber effluent too chemical and biological methods of treatment are available — the biological methods offering more promise over the chemical methods, Yapa (1984).

There are several biological treatment methods that could be used, since these are simple, inexpensive to build and maintain. Some of these have been tried out in other rubber growing countries and will be considered here.

Anaerobic/Facultative ponding system

The Anaerobic/ Facultative treatment system consists of a system of 3 ponds. The first pond called the rubber trap would have particles of rubber floating on top for recovery. In the second the anaerobic bacteria introduced by seeding with sewage sludge would reduce the BOD and COD. In the third pond BOD and COD are reduced further due to oxidation. After treatment in the oxidation tank the effluent would be having low values of COD and BOD and would be suitable for discharge. This system repoted by Yapa (1984) quoting Ibrahim (1978) is shown in Figure 14.

In Malaysia currently there are about 200 such systems in operation and more are under construction (Yapa 1984). It has been established that for rubber effluent with BOD of 1500 mg/ l the average hydraulic retention times to bring down the effluent to BOD less than 150 mg/ l would be 12 hours for the rubber trap, 10 days for the anaerobic system and 12 days for the facultative system–a total of 22½ days. The long residence period has been considered a disadvantage of this process which requires very large tanks and thus an extensive land area and also sometimes the lowering of the BOD and COD are not sufficient to meet the CEA standards. Also this process leads to serious problems of malodours which usually accompanies the anaerobic process. This limits the application of this treatment process to areas which are at acceptable distances from residential areas.

An alternative method — the oxidation ditch method which has a much shorter residence time of 7 days has been developed by the Rubber Research Institute, Malaysia. This is an aerobic process unlike the former. Aeration is achieved by using two cage rotors placed across the ditch. The effluent after treatment in the ditch passes to a tank where settling of the sludge and other matter takes place. After this the effluent which has low COD and BOD is suitable for discharge. If the rate of aeration is increased a higher loading of BOD can be accomodated thus reducing the land requirement.

Another method for the treatment of rubber effluent is biological oxidation using the rotating biodisc. The rotating discs provide a surface for the growth of the bacterial film. The rotation of the discs provide contact between the micro-organisms and the wastewater and adequate supply of oxygen to the micro-organisms (Karim and Ibrahim 1984) as quoted by Yapa (1984).

Another system that is being tried out in Malaysia for rubber effluent treatment is the Upflow Anaerobic filter. Here an anarobic filter is basically filled with packing whose surface is suitable for micro-organisms to accumulate. The rubber effluent is added at the bottom of the filter and this flows up through the packing coming into contact with the micro-organisms. During this upward movement it gets treated and it also gets free of biological solids. The advantage of this method is the reduction in the land area requirement. However this method has not yet been tried out on a commercial scale.

Like for distillery waste treatment, for acid effluents too aquatic weeds could be used for the "final polish" in the treatment process.

Even though there are no rubber effluent treatment systems installed in the Kalutara district, work is going on in this field both at the Rubber Research Institute, Agalawatte (RRI) and the CISIR. Yapa of the RRI in 1984 has prepared a comprehensive report on "Factory Effluents in Rubber Plantations in Sri Lanka — its disposal/ utilization and control of pollution, on a project under the NORAD Consultancy Service Fund. This report examines the methods available for pollution control and gives recommendations for installation of treatment

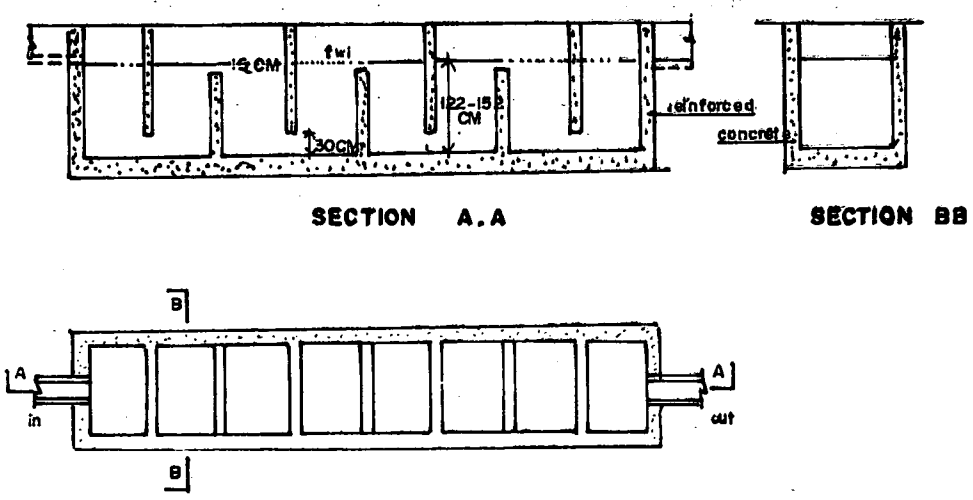


Figure 14 – Anarobic Facultative treatment system (from Yapa, 1984)

systems and also has carried out trials with rubber effluents as a fertilizer. Yapa has also initated work on the treatment of skim serum and crepe serum on a laboratory scale using the Anaerobic/ Facultative system. Jayaweera (personal communication) has worked on skim serum of average BOD value 4800 mg/litre. She has worked on a single tank and a two tank system using water hyacinth plants using serum diluted 6 times. In the single tank system water hyacinth plants were introduced into the single tank, where as in the two tank system the first tank was an anaerobic tank and the plants were introduced into the second tank (the facultative tank). Jayaweera's work showed that about 20 days were required to reduce the BOD levels to permissible levels for discharge.

At the CISIR Dr. Mathis of the Environmental Science and Technology Division, has carried out work on rubber effluents. This division has tested out methods of treating rubber effluents on a pilot scale at the CISIR. Since these have been successful it has been installed at Devalakande estate, Dehiowita on a pilot scale and will be installed on a large scale at Sirinivasa estate, Waga. This treatment method is the Activated Sludge Method. The rubber effluent at the initial stages treatment has a BOD of around 1500 mg/ l and on aeration using the activated sludge method the BOD reaches around 50 mg/ l in about 12 hours and is discharged. The micro-organisms necessary for this process is obtained from the activated sludge collected from the sewage treatment plant, Kalubowila and is seeded at the begining of the process. The pH of the effluent is adjusted to neutral at the initial stages with lime. Once the system is working there is no necesscity to adjust the pH. Discussions held with Dr. Mathis revealed that system is operating well at present in Devalakande estate. The cost of installation is not prohibitive since it involves building of 2 concrete lined tanks, each tank of sufficient capacity to hold about half the discharge/ day/ factory. Since the treatment needs 12 hours retention time, the treatment can be done 2 batches per day.

This method has the advantage that it does not require a large extent of land for the installation of the treatment system like for the oxidation ditch method. It is more efficient than the Anaerobic/ Facultative system since the retention time is much less. However here the process becomes costly because of the need for energy for aeration.

In Sri Lanka the oxidation ditch system is in operation for the treatment of rubber effluent at Brahmanagama, Kottawa – at a rubber glove manufacturing factory Dipped Products Ltd – a company of Hayley's. This system has been operating for about 5 years and is functioning well except for a few months each year.

Recommendation for Protection/Mitigation

Thus for rubber effluent, treatment processes are available in Sri Lanka. The action plans for treatment processes should be drawn up after taking into consideration the location of the estates/ industries. The factors that should be considered are whether the estate/ industry is near human habitation or in urban areas, the availability of land for installation of the treatment plant and the cost factor.

Since the techniques for treatment of rubber effluent has been worked out, the CEA should persuade the Rubber Research Institute, Agalawatte located in the major rubber growing district of Kalutara to take steps in collaboration with the CISIR to install various methods available, in the RRI premises or in one or two estates in Kalutara and carry out long term studies about the suitability of the various process for pollution control. Thus depending on their performance the RRI should be in a position to recommend the method that should be adopted by the owner/ company of the rubber estate/ industry.

Once the efficiency of the systems have been worked out by the RRI, a deadline of 10 years from that time should be given for estates/ industries to set up the treatment processes. If no attempts are made heavy penalties should be imposed.

CHAPTER 11

PROBLEMS CAUSED BY FARM WASTE AND SLAUGHTER HOUSE WASTE

The Kalutara district faces more problems connected with pollution by bio-degradable organic substance in the wastewater, This chapter deals with two such problems farm waste and slaughter house waste.

Farm waste

This is a problem reported for the Bulathsinhala AGA division and the pollution is caused by the waste from the Chris Thombu farm. Chris Thombu farm is one of the big farms in Sri Lanka responsible for the supply of eggs, chicken and pork to various parts of the island.

Farms generate a considerable quantity of waste-feathers, blood, offal, faeces, washings from slaughter houses and animal houses etc. In Sri Lanka farm waste is generally released into water courses, paddy fields or marshy land without any treatment. The daily addition of such wastewater leads to severe pollution problems as discussed in chapter 9 and 10. For the Chris Thombu farm it is not possible to get the exact quantity of wastewater generated per day. But a reasonable estimates could be obtained from the amount of water used per day which is around 3300 cubic m/day.

The problem of waste disposal by the Chris Thombu farm has been brought to the notice of the District Environmental Agency of Kalutara. The original problem reported was that this waste was making some of adjoining paddy fields uncultivable. To overcome this problem the AGA of the division had suggested that a large pond be dug out so that wastewater could be led in there. The management of the Chris Thombo farm has responded well to this suggestion and has constructed this large unlined pond as instructed by the AGA. On site examination it was revealed that even though the large pond has been constructed up to now all the wastewater has not been diverted to it. Like in most situations the management and the people who complained feel that something has been done even though in practice no proper treatment is taking place.

Since at present no treatment is done for the wastewater, samples were collected from the slaughter house of the Chris Thombu farm after chickens have been killed and various parameters of this wastewater were determined.

The results are as follows:-

pH 6.2

Suspended solids from 660 - 1100 mg/l

BOD in 5 days at 20°C - 12,780 mg/l

The results show that the wastewater has values for BOD and suspended solids much higher than the CEA permissible levels of discharge. Hence some treatment has to be carried out before discharge. Since this wastewater has no chemicals in it and also since it has no pathogenic organisms the wastewater after treatment could be reused in the farm itself or aquatic plants could be grown in it and be harvested and used either as animal feed or for other purposes (National Academy of Sciences 1976).

Many methods are available for treatment of such biodegradable waste. As mentioned in chapters 9 and 10 biological treatment by using stabilization ponds seems the most appropriate for treatment of such waste. A low cost method suitable for the treatment of farm waste would be a facultative pond system. Facultative ponds operate both aerobically and anaerobically at the same time. The aerobic layer is near the surface of the water while the anaerobic processes are associated with the sludge and the lower levels of the pond. Aerobic stabilization of waste is

quicker and more complete than anaerobic stabilization. It is beneficial if the process is aerobic as much as possible. The ponds are easier to operate and create less nuisance if a pre-treatment unit in the form of screens and a grit removal channel is employed. If there is a shortage of funds this pre-treatment is generally omitted. If this is so it is necessary to create a deeper grit collecting section of the pond immediately below the inlet and to establish a procedure for breaking up and removing mats of floating detritus. The depth of the facultative pond can be critical. If it is too shallow rooted weeds and filamentous algae will grow on the bottom and disrupt flow, trap detritus and inhibit mixing. If the pond is too deep beneficial mixing will be inhibited and solar radiation will penetrate only to a limited part of the total depth. The accepted depth of the facultative ponds is generally 1.5 m (Ellis 1982). For efficeint working of facultative ponds there should be a vertical movement within the water to carry the oxygen rich waters of the surface deep into the pond.

After bringing down the BOD to reasonable levels a fully aerobic stabilization pond can be employed as the final treatment process. These ponds or systems can be employed to lower the concentration of biodegradable organic material, to reduce the bacterial count in the wastewater, to oxidies any remaining ammonia to nitrate, to lower the concenration of suspended solids and to lower the concentrations of soluble nutrients – nitrates and phosphates.

In these aerobic ponds plants could be grown and used as a "final polish". Thus even though several plants have been found to be suitable as indicated in chapter 9 the choice in the case of farm waste should be a plant that could be used to feed cattle or pigs or what ever animals the farm hosts.

Wathugala, Suzuki and Kurihara (1987) have used *Phragmites australis* to remove nitrogen, phosporus and COD from wastewater from Corn Steel Liquor. In Singapore high-rate algae stabilization ponds have been used for treating wastewater generated from a pig population. (IRDC report on wastewater treatment and resource recovery 1980)

There are certain problems associated with having large areas of shallow, near stagnant ponds in countries where mosquito borne diseases like Malaria and Filariasis is present. This is applicable to the treatment of distillery waste and acid effluent discussed in chapter 9 and 10. The culicine mosquito spreading filaria is a dirty water breeder and can be associated with the facultatives pond while the *Anopheles* mosquito which carries Malaria is only associated with cleaner waters and this danger may be limited to the substantially purified waters in aerobic ponds. The ponds should be thus designed to avoid the presence of any mosquito larvae. Stocking the ponds with fish represents an effective defence against the spread of mosquito borne diseases.

Recommendations for Protection/Mitigation

Thus for the Chris Thombu farm waste a facultative pond should be designed to hold the wastewater till the BOD value gets reduced to about 200 mg/ 1. It should then flow into an aerobic pond to bring down the wastewater to the CEA standards of discharge. In the aerobic pond emergent plants which could be used as animal feed should be used. Part of these plants should be harvested from time to time to prevent covering the surface of the water so that air movement can take place freely. Fish should be introduced into these ponds so that these could feed on the mosquito larvae.

Instead of an aerobic pond the partly treated effluent could pass over a bed of gravel topped with sand in which emergent marsh plants (like *Elaeocharis sp.*) are planted. The marsh plants grow quickly spreading their roots through the gravel. Wastewater could be spread over the surface of the bed with plants so that the solid particles get trapped on the sand as the water percolates downwards. Dissolved organic and inorganic material is absorbed by the reeds or decomposed by the micro-organisms on the gravel. Since leaves, stems and roots of the common marsh plants have air passages in them, oxygen is transported down through the plants and outward from the roots to soil to supply the needs of the micro-organisms. By creating a route for rapid transport of oxygen to deep portions of the bed, the plants increase the efficiency of the breakdown of organic material. In these systems if standing water is not permitted insects and insect larvae do not appear in large numbers and also there are no problems of bad odours (Sprangler, Sloey and Fetter 1976). Thus the emergent vegetation provides a suitable way of bringing down the effluent levels to the desired standards. The marsh plants should be harvested at regular intervals and these could be used for traditional crafts like weaving mats, bags etc. which would be very useful for a district like Kalutara well known for its handicrafts!

Slaughter house waste

A problem similar to the pollution caused by Chris Thombo farm has been reported from the AGA division Panadura. This is connected with the disposal of slaughter house waste at Sarikkamulla. At Sarikkamulla slaughtering is done daily except on poya days. The number of cattle killed is variable – the highest being around fifteen during festival seasons. The problems created are due to several reasons. The location of houses close to the slaughter house makes living here very unhygenic. Also the canal leading from the slaughter house which joins up with the river is blocked.

Recommendations for Protection/Mitigation

The space available around the slaughter house is insufficient for the installation of a treatment facility. Hence the immediate solution to this problem would be to clean up the blocked canal system which would enable the waste to flow into the river. Also the slaughter house should be cleaned up properly after the animals are killed by removing all the unutilizable material which should be collected and buried at some site located outside and finally by washing the floors very well.

The long term recommendation however would be to relocate the slaughter house in an area which should be away from residences. A treatment system similar to the facultative pond can be adopted to treat this type of waste. A very important aspect of relocating is to site it in a place removed from residences. With the increase in population in Sri Lanka, people are constructing houses in locations which are not suitable for human habitation. So once an area is ear marked for a slaughter house the land adjacent to this should be bought by the state if it is under private ownership and fenced and kept strictly as the premises of the slaughter house. In the event of this demarkation not being done people would build houses close to the slaughter house and again complain about the improper siting of the slaughter house and the problems!

CHAPTER 12

GENERAL RECOMMENDATIONS

In chapters 4–11 the environmental problems of the district have been highlighted and possible measures for protection/mitigation have been recommended. It can be seen however that solving some environmental problems of the district is not too difficult since there are already existing plans or feasibility studies going on to solve these. The major problems that have to be solved would be those connected with the effluents containing biodegradable wastes dealt in chapters 9, 10 and 11. It is therefore essential that people already working on these aspects genuinely be contacted and requested to draw up action plans in consultation with civil engineers who have designed such treatment systems earlier. It is also very necessary to visit any treatment plants dealing with similar waste already in operation and hold discussions with the management to find out the problems that are encountered. The experience thus gained would also be very useful to draw up action plans.

An environmental action plan is an implementation plan for a specific mitigation, protection and/or enhancement measure which is recommended in an Evironmental Assessment (Handbook on Environmental Impact Assessment 1987). Thus any action plan should give in detail how these measures should be designed and operated, the resources required and the schedule for implementation. The action plans that would be drawn up under the guidance of the CEA in connection with the Kalutara district therefore really transform the recommendations for protection/mitigation indentified for the environmental problems, to individual projects ready for implementation. Thus to draw up the action plans to overcome or mitigate problems needs a substantial amount of funds. Working, through the District Environmental Agency part of the funds necessary for drawing up some of the action plans can be generated within the district itself from the developers who generate polluting effluents or create environmental problems. In this way the CEA could get proper action plans drawn, in some cases after experimentation with the effluents. If the developers have contributed in some way towards making the action plans possible, than they would be more enthusiastic towards the implementation of the treatment system indicated in the action plan.

In addition to the environmental problems mentioned, there are a few essential steps that could be taken by the Kachcheri through the AGA's of the division to preserve the environmental quality of the district. One such step is to clean up all inland waterways. Some of the problems discussed would get worse when the waterways are blocked and it is not possible for the water to flow freely. Thus it might be necessary to dredge some of the canals and remove the silt and also clear up any sand bars etc. which block the mouth of these canals. It is beneficial if the banks of these water courses are stabilised with vegetation.

Another precaution that seems necessary applies not only for the Kalutara district but to Sri Lanka as a whole. With development, a major need that arises in any district is the widening of roads. In Sri Lanka in most of the urban areas road widening is done very haphazardly by initially closing up the surface drains to get more width for the road. This leads to a very muddy, unpleasant and unhygenic situation during the rains. This type of initial widening of roads should be prevented at all costs. A narrow road with good drains to take away the surface water flow is more pleasant and healthy than hell holes during the rains.

Zonoing seems to be another method that could be adopted to preserve the quality of the environment. In some urban areas it is not possible now to relocate the existing factories etc. But efforts could be made in other areas to have a systems of zones – for industries, for residences, for agriculture etc.

In addition to solving the environmental problems that are in existence at present, one of the most appropriate methods to preserve the quality of the environment is to employ a set of guardians of the environment. It is

proposed that the district should have enviromental officers attached to the Kachcheri to help in the planning and implementation of projects and also to help in the monitoring of projects and their effect on the environment. To perform these functions the environmental officers should be people trained at the Universities through courses which are interdisciplinary. They should be graduates preferably with an M.Sc. in Environmental Science. These officers should be paid adequately and given sufficient powers to stay action on any projects or any actions detrimental to the quality of the environment. Adequate salary is an essential feature since there is likely to be corruption if the remuneration is insufficient and projects without adequate control measures could be allowed to go on or be implemented. These officers could operate at the grama niladhari level so that they would be aware of any project undertaken even at a private residence. At present the Urban Council checks the suitability of siting buildings but does not examine what type of environmental problems the project will create. The environmental officers if they work at the grama niladhari level could check even the small scale projects. Small scale projects sometimes start on a small scale but later expand without the proper facilities for the staff working there, without proper waste disposal methods etc. Thus these environmental officers should operate both at the self employment and other higher levels. When projects are planned, the plans should be submitted to the G.A. through whom it should be directed to the environmental officers. The environmental officers should be given time to study these documents and later a meeting should be arranged with the developer to clarify any points which are not clear or to point out shortcomings of the project. Ideally for a district there should be a number of environmental officers. Even though their final training is interdisciplinary the basic approach of these people would be according to their basic University training ie. whether they were with a Biological Science, Agriculture, Physical Science, Social Science background. So ideally for a district there should be several environmental officers chosen from different fields of study. Thus when plans are submitted for large scale projects this team of environmental officers could meet and discuss whether the various aspects have been looked into and submit their deliberations to the G.A. When such a team is working it is possible that things would be done faster and the chance of a developer trying to bribe and obtain approval will be much less. Also if the environmental officers have to monitor certain projects to determine whether the effluents etc. are up to the CEA standards, one well equipped laboratory for the district with a trained technician is an essential feature. It is not sufficient to collect samples and send them across to the CISIR or Water Supply and Drainage Board for testing.

Another very important feature for the preservation of environmental quality of the district is environmental education for the people. The people should be taught about the environment, the abuse of the environment, how it affects their lives and that there are ways of avoiding or mitigating the adverse effects. Also the people should be told to be aware of any projects that are likely to come up in their locality. Sometimes people do not protest about a project even if they are aware of the environmental problems the project is going to cause, since they feel that if they complain they would loose a possible chance of employment in the project. What poeple should be made aware of is that if they are united they could get employment and also see that the environment is not polluted or degraded by the developer. This type of emphasis has to be given in the environmental education course. The ideal traget group would be the school children at the G.C.E. Ordinary Level and Advanced Level classes. This education should be done by the environmental officers in collaboration with the University staff or voluntary organisations like the March for Conservation. Through this target group information could penetrate upwards to the parents and downwards to the sisters and brothers.

There is another aspect of education necessary to preserve quality of the environment. It is an accepted fact that enviromental problems are aggravated by population explosions. Therefore education should be given on disadvantages of large population increases and on methods of population control. Steps should be taken at hospitals, schools, rural development societies etc. to explain the various techniques available for family planning. Discussions with the Family Planning officers reveal that the average Sri Lankan male is not very keen about family planning and would prefer it to be in the hands of the females. Hence efforts should be made to reach the females not only in the urban but the rural areas as well.

Lastly the recommendations given so far has to be directed and organised through action plans by the CEA. At present the CEA plays a co-ordinating and a policy making role only. If the environment is to be looked after the CEA should be given greater powers for an administrative and a regulatory role. Without these powers at the top no amount of recommendations are likely to work. So it is hoped that the CEA gets the adequate power to stop the degradation of the environment. With the regulatory powers granted to the CEA the environmental officers too would have more power and backing and hence would be in a better position to help to preserve the environmental quality of the Kalutara District!

REFERENCES

Abeywickrame, B. A. (1987) Diversity and endemism and the need for conserving representative areas with national boundaries. A paper presented at UNESCO/CEA workshop on Ecology and Conservation of Tropical Humid Forests of the Indomalayan Realm, Sri Lanka, February 1987.

Accomodation Guide (87/88) Ceylon Tourist Borad.

American Public Health Association (1965) Standard methods for the examination of water and wastewater including bottom sediments and sludges.

Arends, Ir G. J. and Donkersloot - Shouq, S. S. (1985).

An overview of possible uses of sawdust. TOOL foundation, CICAT and CICA CMP, Netherlands pp. 1 - 197.

CISIR Report (1987) NR/TS - 133 on waste water from distillery.

Coastal Environmental Management Plan for the West Coast of Sri Lanka (1985) Preliminary survey and interim action plan ESCAP/Government of Sri Lanka Report, Bangkok.

Ellis, K. V. (1982) Stablization ponds : design and operation. CRC Critical Reviews in Environmental Control, 13, issue 2 pp 69 - 102.

Forestry Master Plan for Sri Lanka (1986) Jaakko Poyry International Oy, Helsinki, in collaboration with Sri Lanka authorities.

Herath, H. M. S. S. D. (1988) Environment and Health, A paper presented at UNESCO/CEA seminar on Environmental Education in Sri Lanka, February 1988.

Industrial Pollution Control Guidelines (1982) iii Brewery and Distillery pp 1 - 25. ESCAP - Evironmental and Development Series United Nations Economic and Social Commission for Asia and Pacific, Bangkok.

Irrigation Department (1974) Annual rainfall and surface runoff (Colombo).

IRDC Report of a workshop on high-rate algae ponds Singapore, February 1980.

Landslide Hazard in Sri Lanka : Some high risk areas (1986) Volume II Kalutara, Ministry of Local Government, Housing and Construction, and National Building Research Organisation.

Madduma Bandara C. M., Wickrema Gamage P. and Wilson W. N. (1987) Coastal changes in Negombo lagoon outfall and Kaluganga estuary. Department of Geography, University of Peradeniya pp 1 - 110.

Nathanael W. R. N. (1953) Toddy effluents from disilleries.

The Ceylon Coconut Quarterly, IV pp 63 - 67.

National Academy of Sciences (1976) Wastewater treatment using aquatic weeds. In *Making Aquatic Weed Useful : Some perspectives for developing countries,* Washington D. C.

Peoples Bank Research Report (1984). A Census on the exploitation of sand and seashell resources in the coastal zone of Sri Lanka pp 1 - 48.

Ripely P (1979) Process Engineering Aspects of the treatment and disposal of distillery effluent. process Biochemistry. Sprangler F., Sloey W. and Fetter C. W. (1976) Experimental use of emergent vegetation for biological treatment of municipal wastewater in wisconsin. In *Biological Control of Water Pollution* (Ed. Tourbier J. and Pierson R. W.) pp 161 - 171.

Sri Lanka Census of Agriculture (1982) General Report.

Department of Census and Statistics, Ministry of Plan Implementation.

Sri Lanka Census of Population and Housing (1981) Kalutara district report Volume I Part III. Department of Census and Statistics, Ministry of Plan Implementation.

Sri Lanka Master Plan Coastal Erosion Management (1986) Volume I - The Plan, Coast Conservation Department, DANIDA - Danish Hydraulic Institute.

Sri Lanka Coast Erosion Management (1986) Volume 4 - South West Coast. Coast Conversation Department , DANIDA - Danish Hydraulic Institute.

Sri Lanka Coastal Zone Management Plan (1987) Coast Conversation Department.

Tolba M. K. (1979) Environmental Management and Biospheral Equilibrium - In *Growth without Ecodisasters* (Ed N. Polunin) Haalsted Press, New York.

Tropical Forest Ecosystems (1978) A state of knowledge report prepared by UNESCO/UNEP/FAO. Published by UNESCO, Paris.

UNDP/UNCHS Training Programme (1988) for members of the District Landslide Monitoring Units organised by NBRO and Land Use Policy Planning Division.

Wathugala A. G., Suzuki T. and Kurihara Y. (1987) Removal of nitrogen, phosphorus and COD from wastewater using sand filtration system with *Phragmites australis* Wat. Res 21, 1217 - 1224.

Wijesinghe L. C. A. de S. (1984) A sample study of biomass fuel consumption in Sri Lanka households. Biomass 5, 261 - 282.

Wijesekera D. and Hettiarachchi S. S. L. (1983) Behaviour of the Kalu ganga outfalln. In International Conference on Coastal Engineering in Developing Countries Volume I, Colombo, Sri Lanka pp 302 - 319.

Wijayadasa K. H. J. and Ailapperuma W. D. (1986) Survey of Evironmental Legislation and Institutions in the SACEP Countries, Sri Lanka. CEA/Ministry of Local Government Housing and Construction pp 1 - 50.

Yapa P. A. J. and Walpita N. C. (1983) Enviromental Pollution and treatment of effluent. In *A Handbook of Rubber Culture* and Processing (ed O. S. Peries and D. M. Fernando) Caxton Printing Works, Colombo.

Yapa P. A. J. (1984) Factory effluents in Rubber plantations in Sri Lanka - its disposal/utilization and control of pollution - Report for a project under NORAD Consultancy Service Fund.